Sept. 17, 1929. W. W. BURSON 1,728,661

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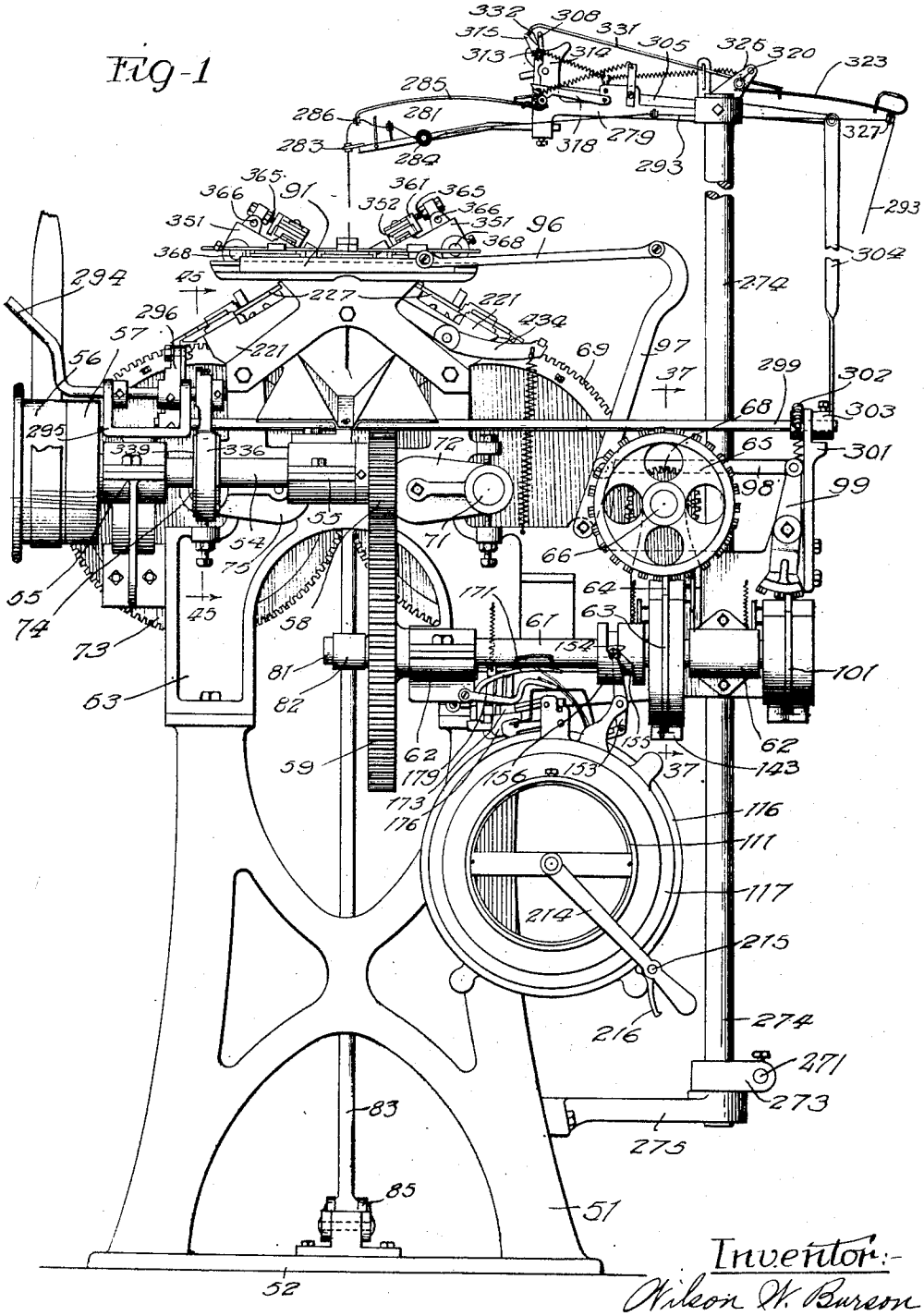
Fig-1



Inventor:-
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By:- Munday, Clarke & Carpenter
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KNITTING MACHINE

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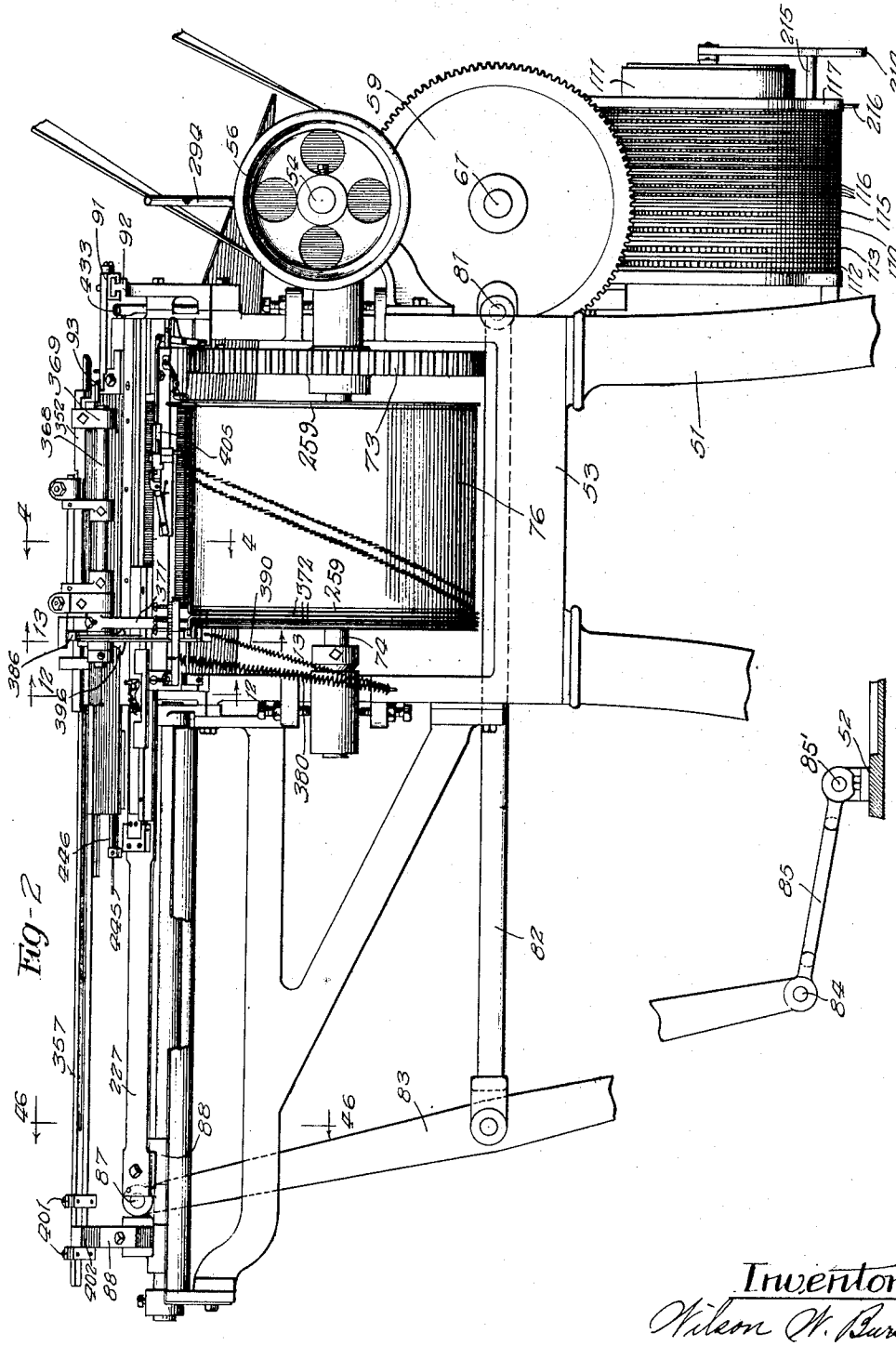

Fig-2

Inventor:-
Wilson W. Burson

By:- Munday, Clarke & Carpenter
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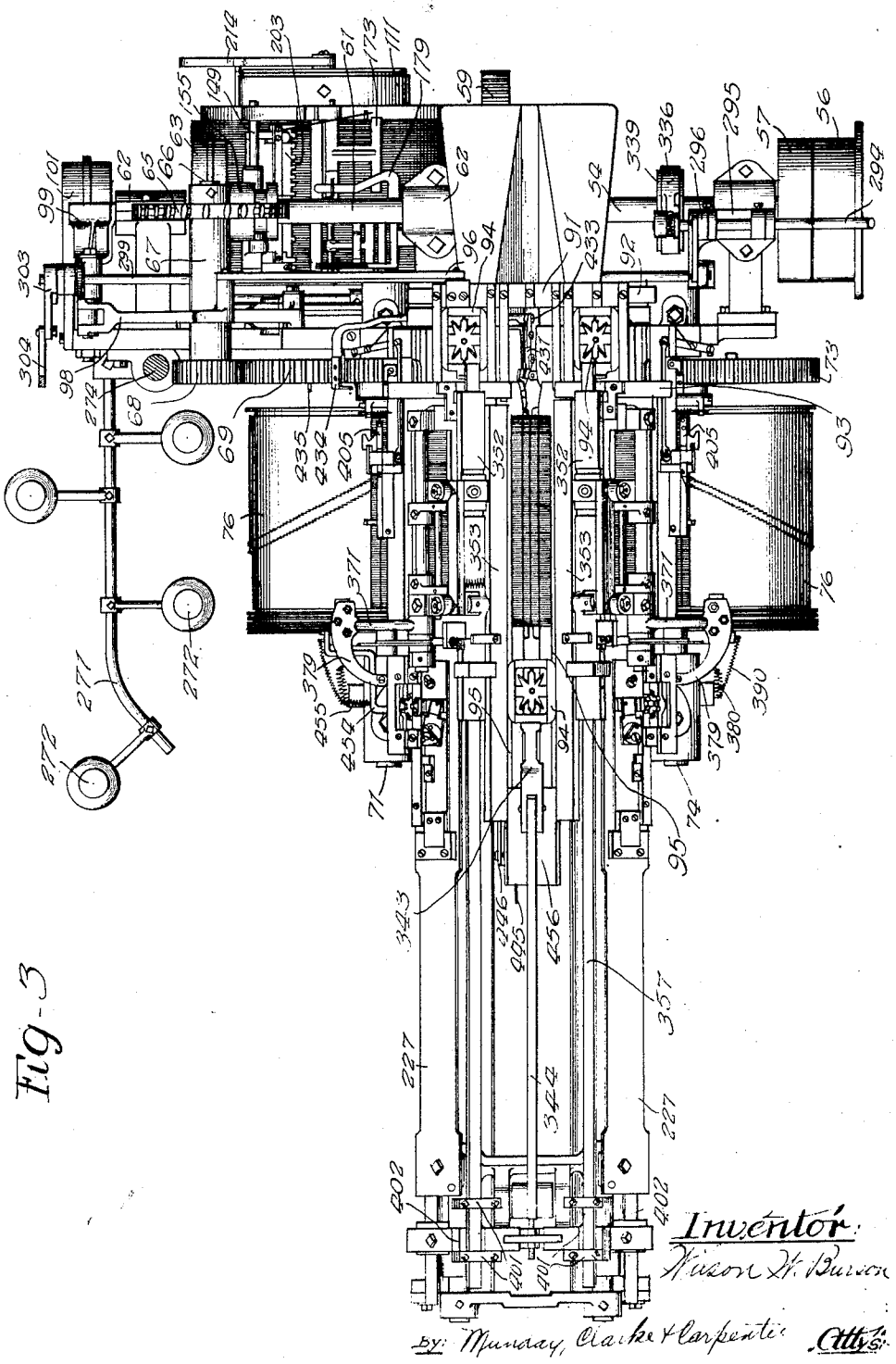

Fig. 3

Inventor:
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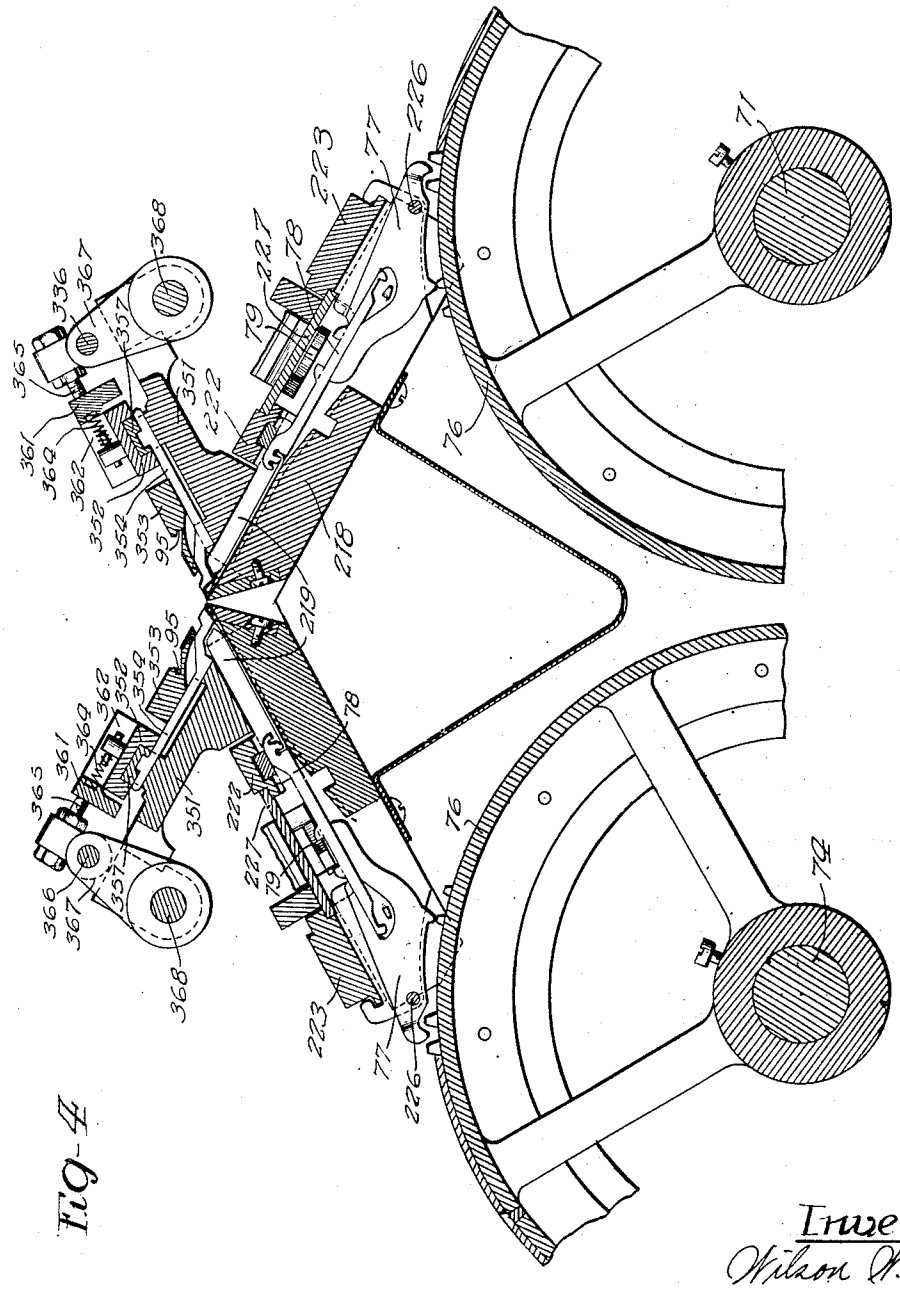

Fig. 4

Inventor:
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Fig-5

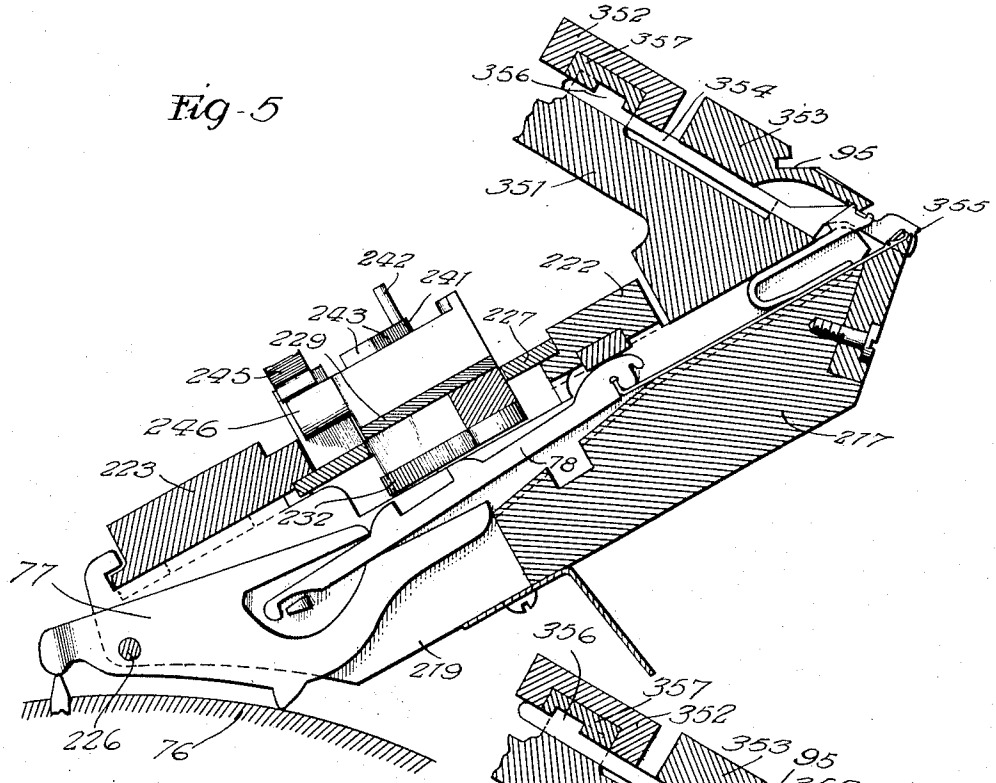
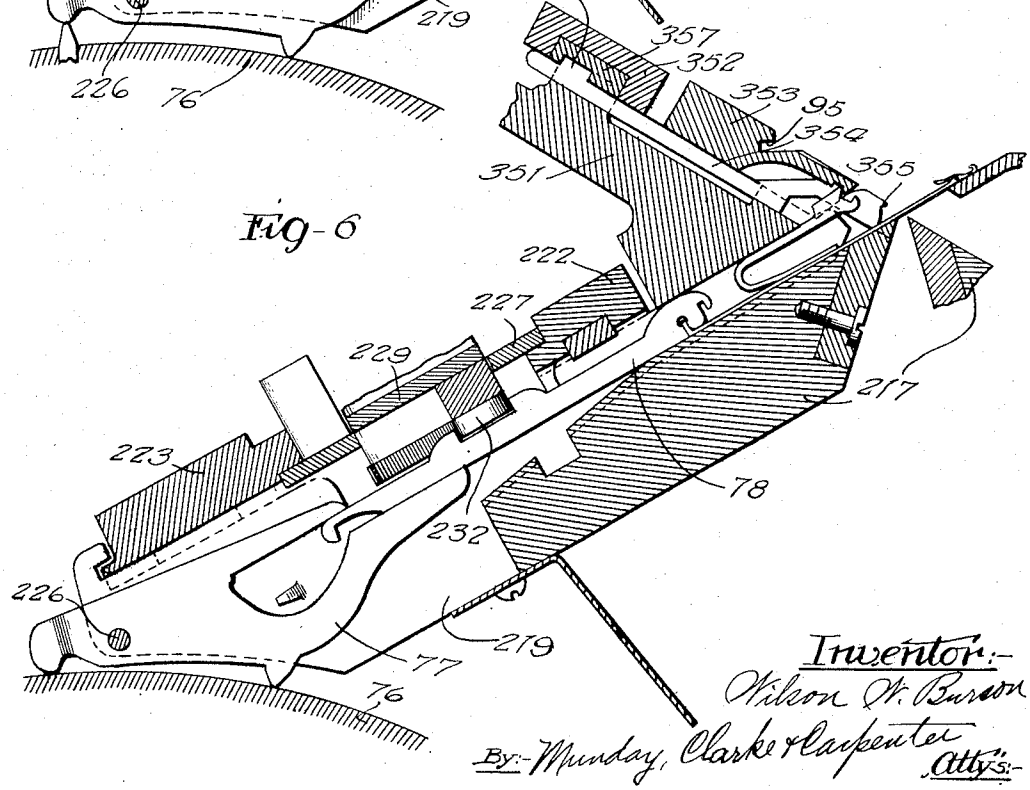


Fig-6



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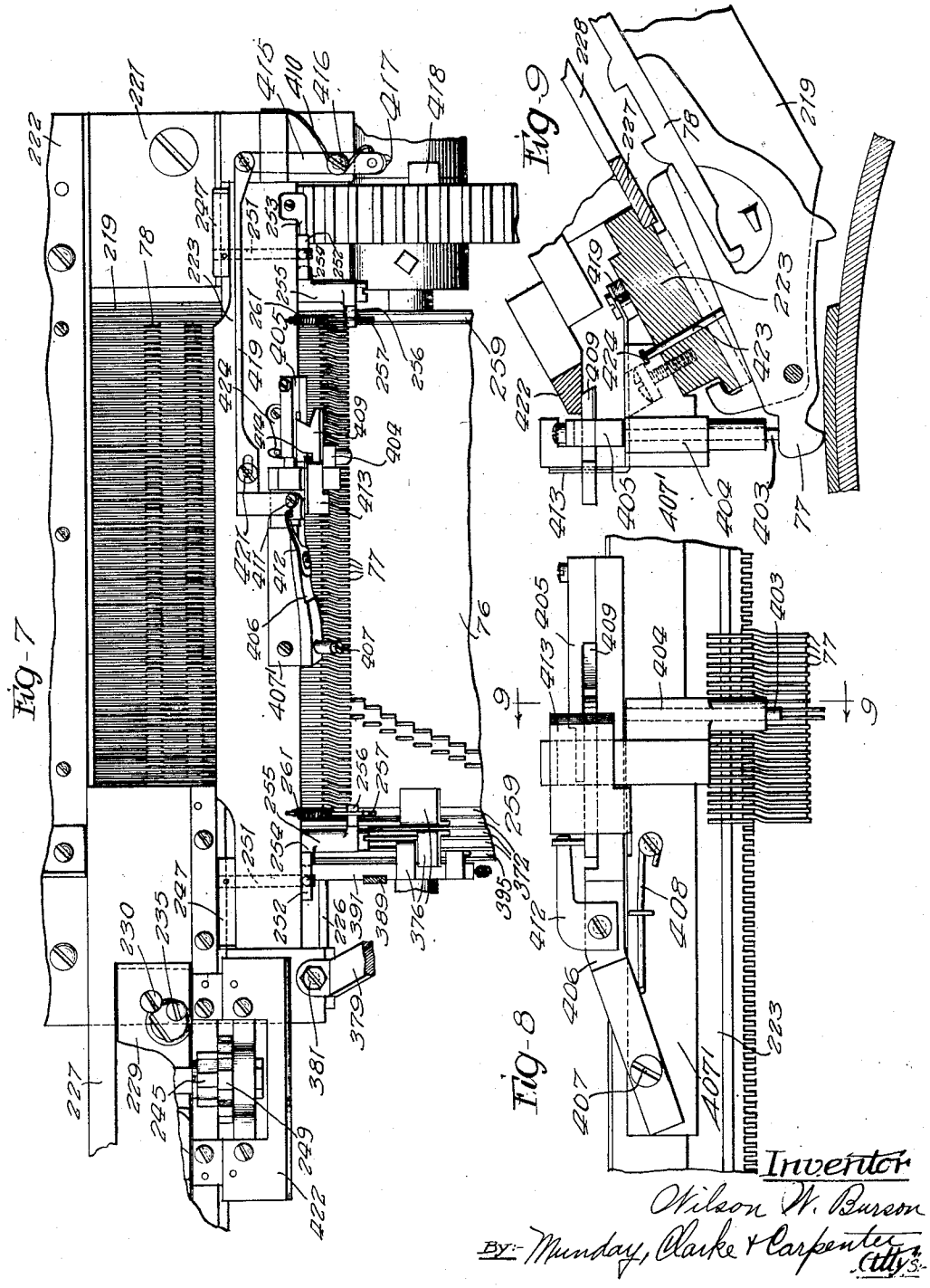

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Fig-12

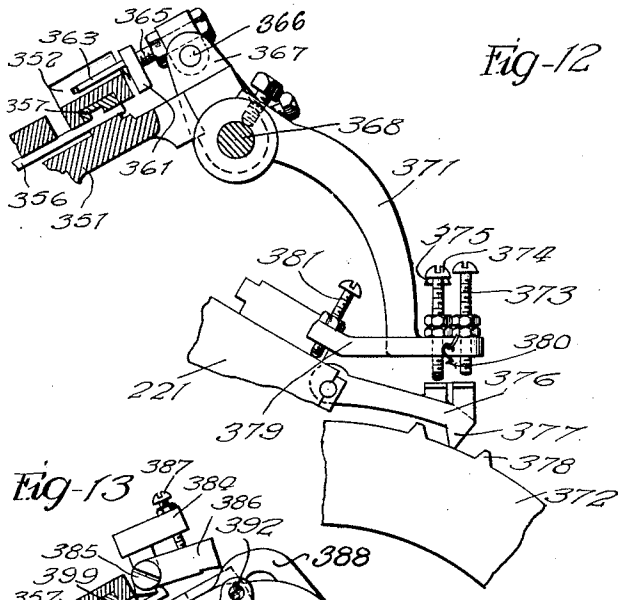


Fig-13

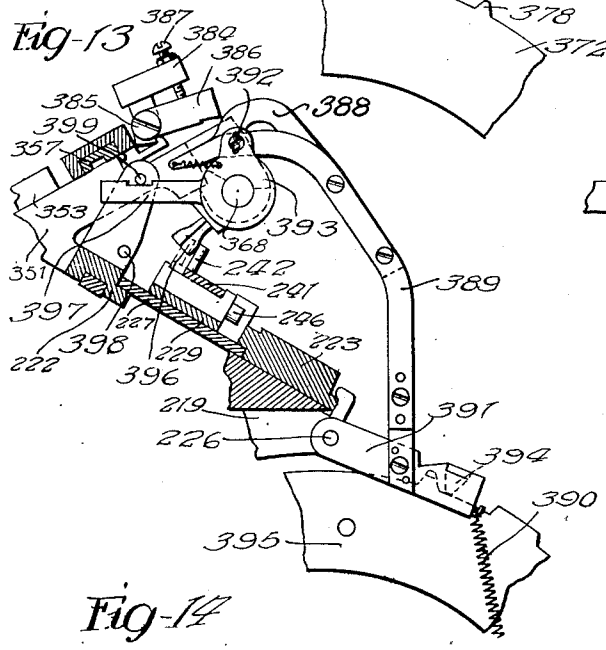


Fig-10

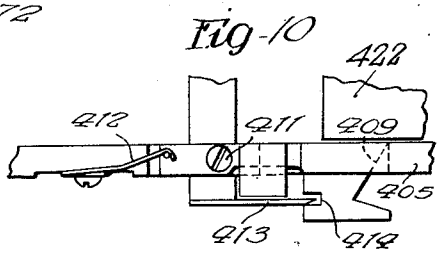


Fig-11

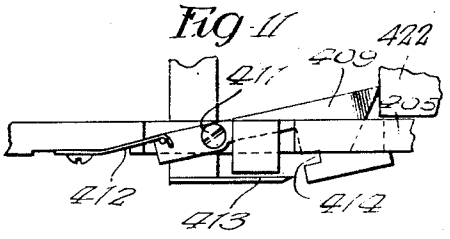
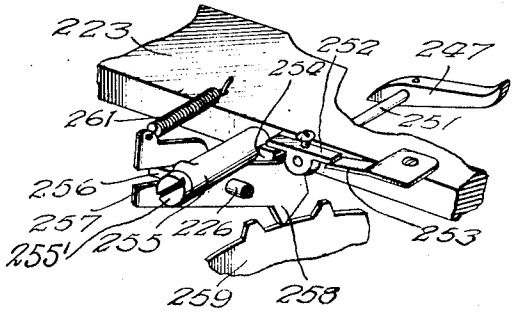


Fig-14



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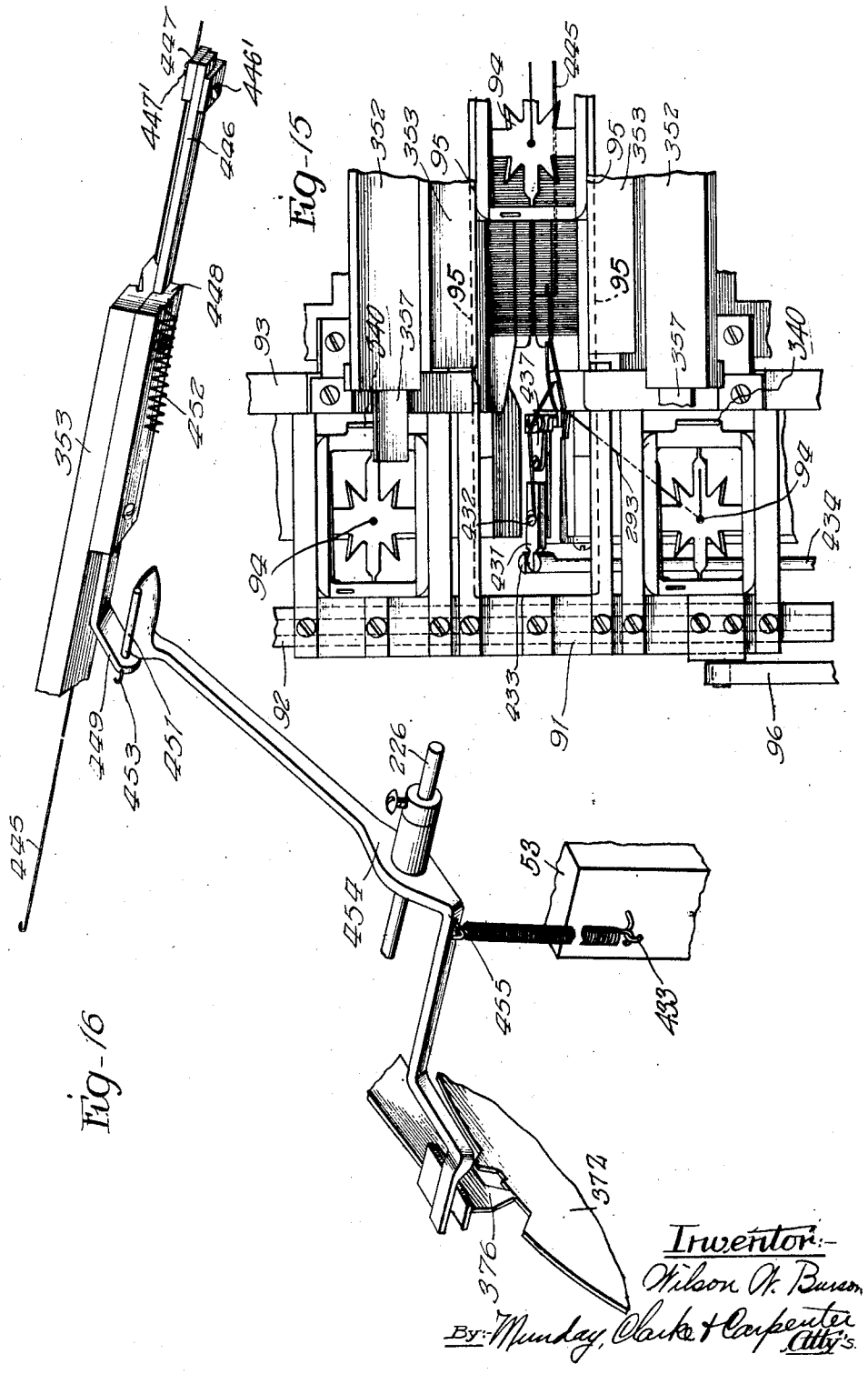

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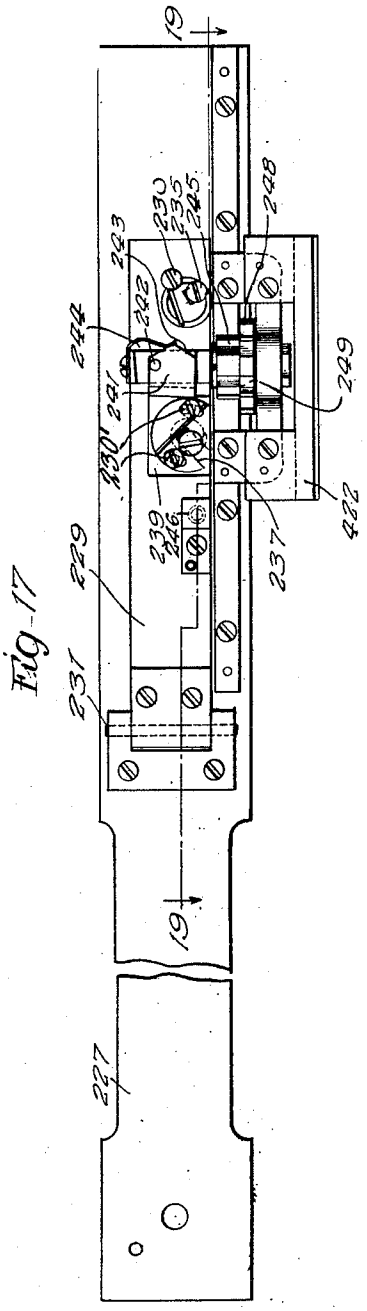

Fig-17

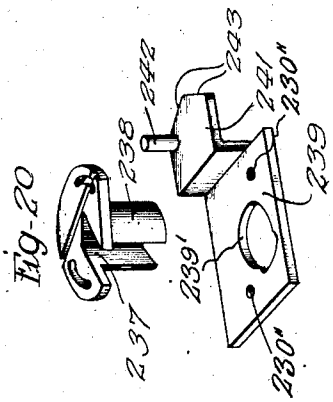

Fig-20

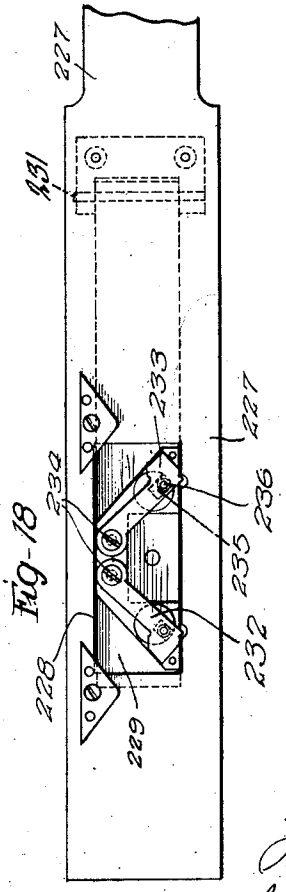

Fig-18

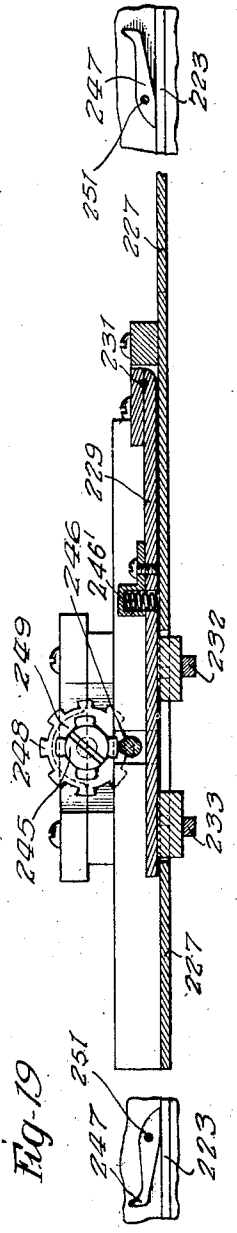

Fig-19

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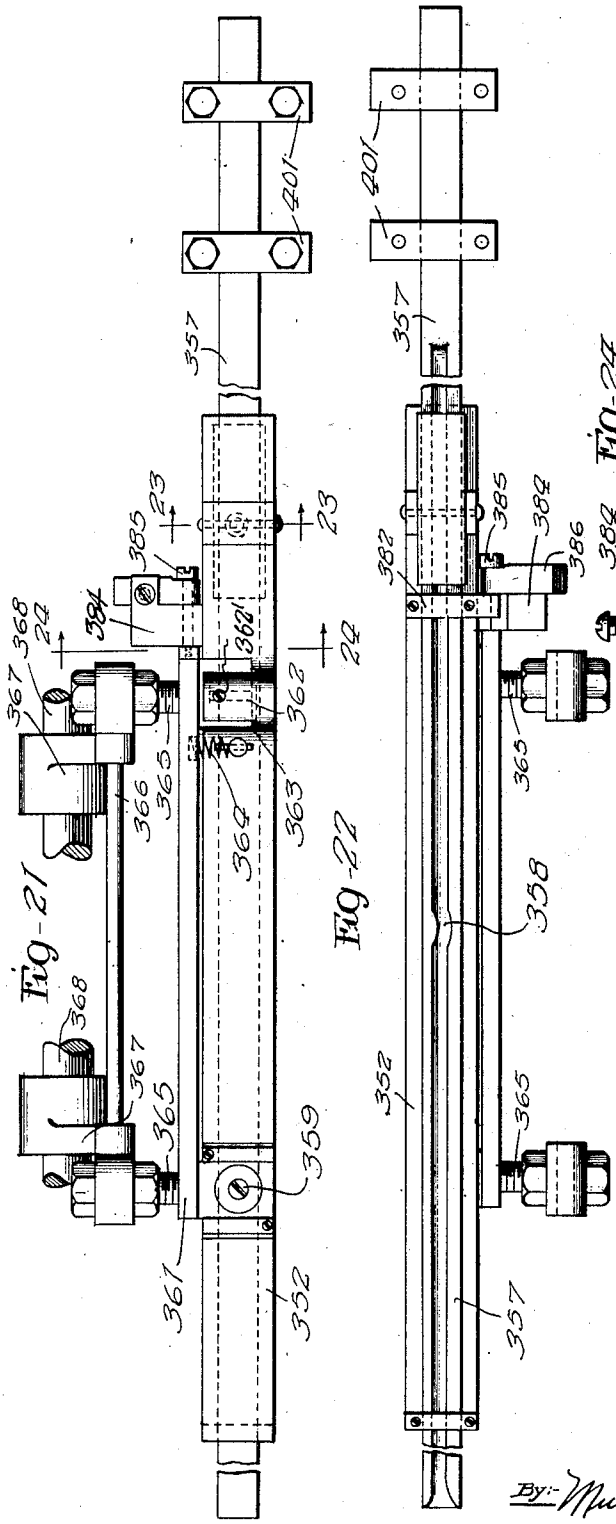

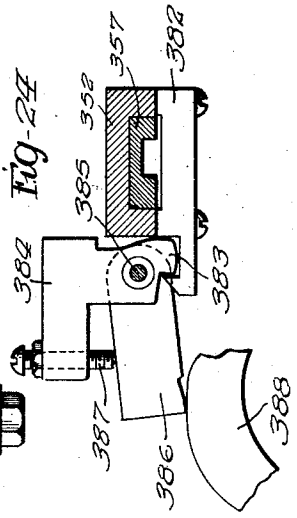

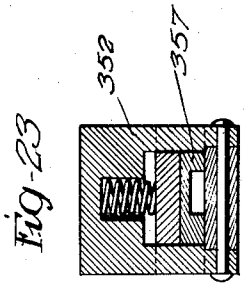

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Fig-25

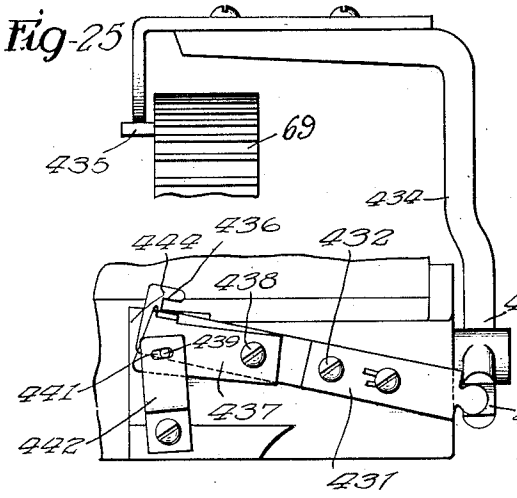
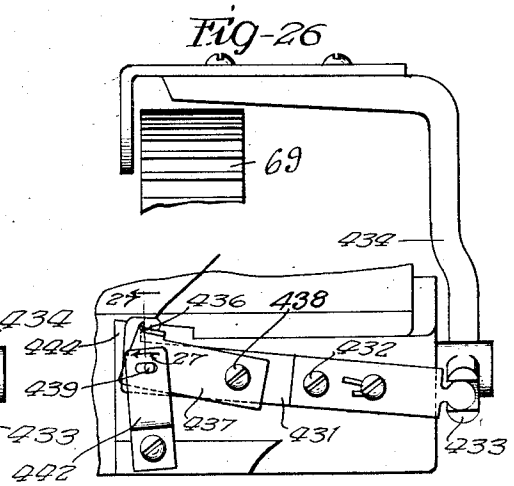


Fig-26



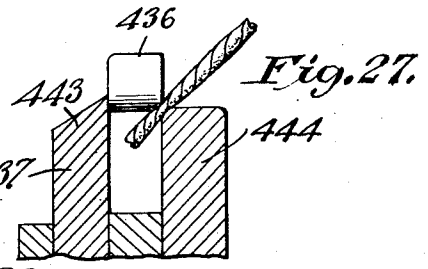


Fig.27.

Fig-28

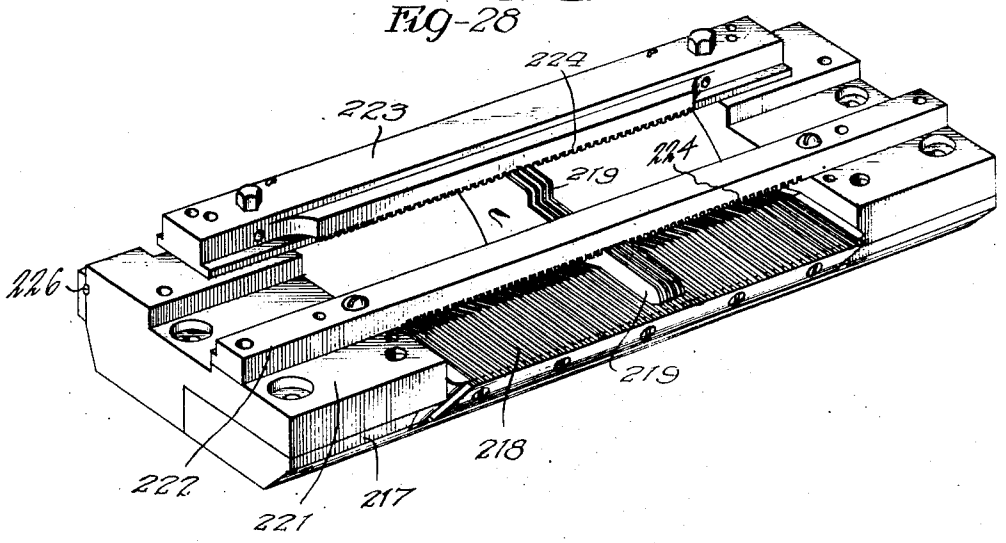


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Fig-29

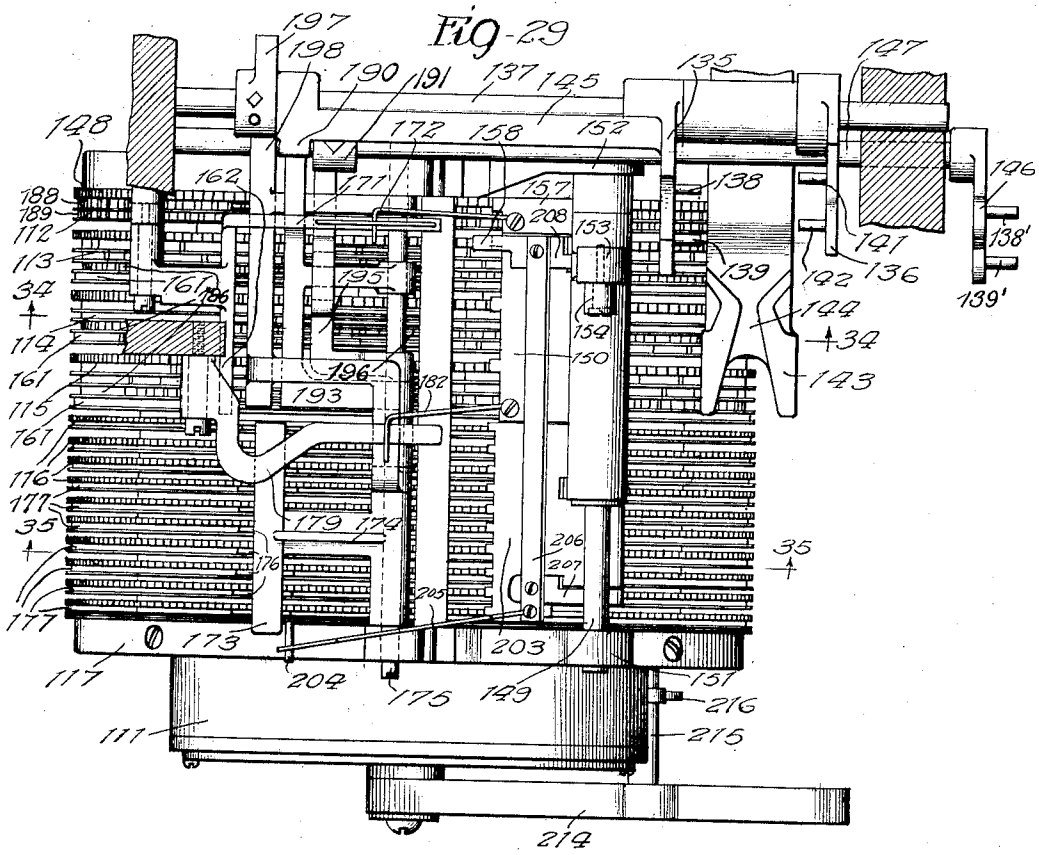

Fig-30

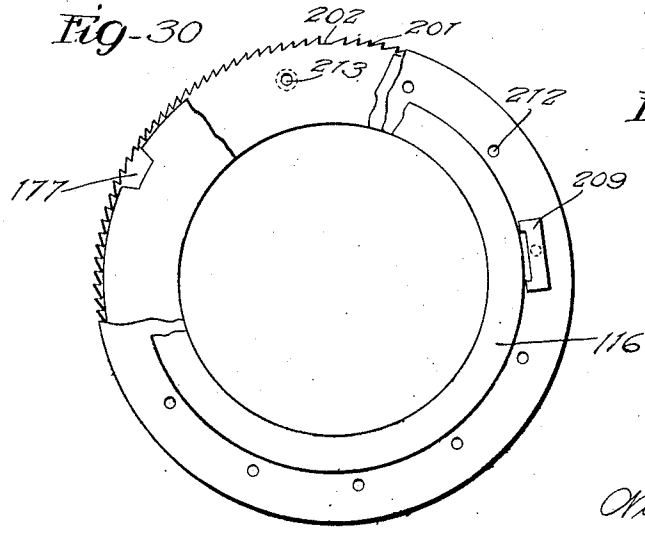

Fig-31

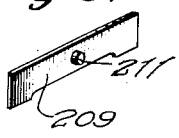

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Fig-32

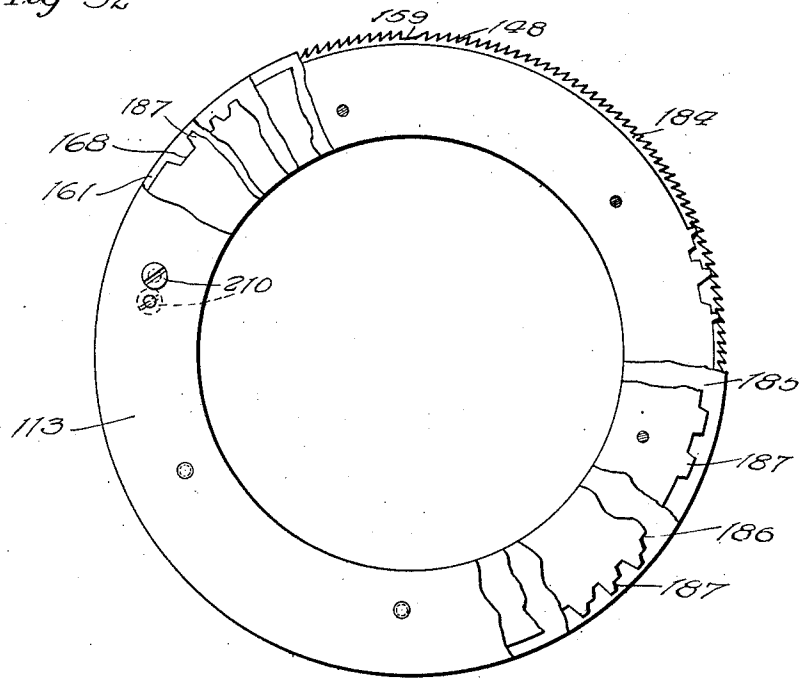

Fig-33

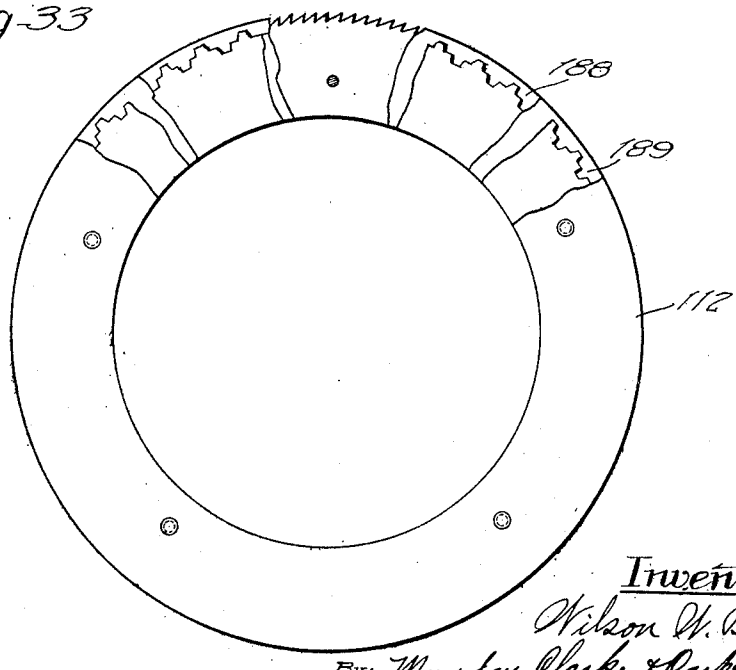

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Fig-34

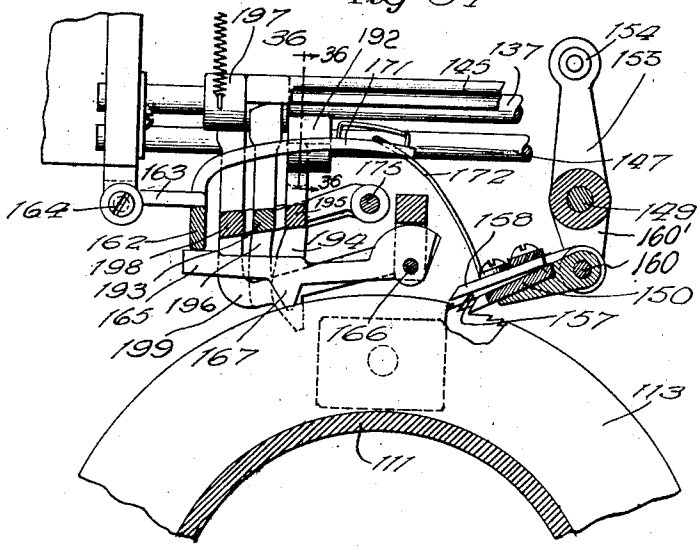

Fig-35

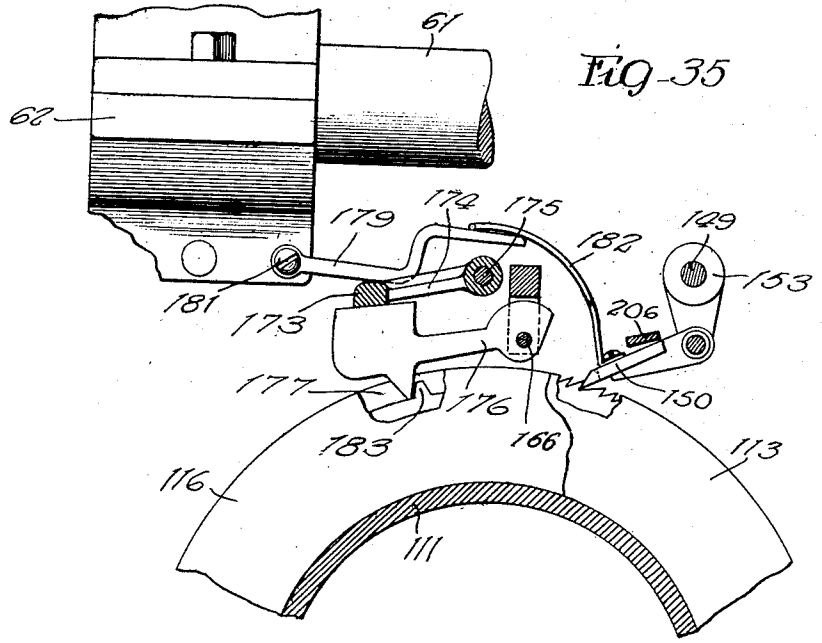

Fig-36

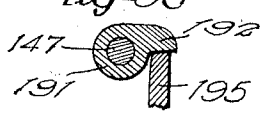

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Fig-37

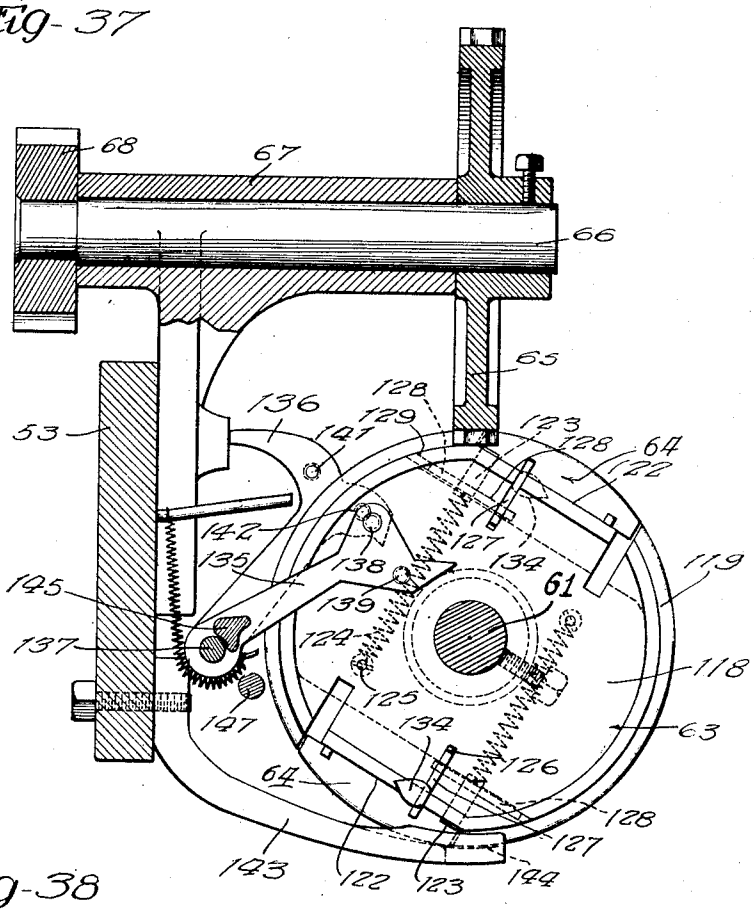


Fig-38

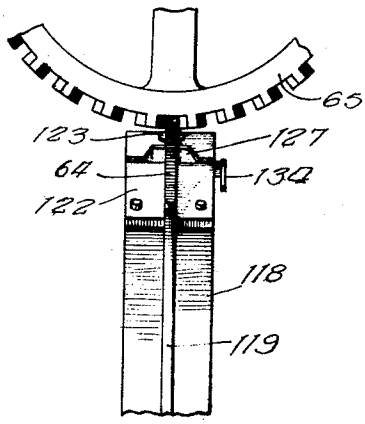
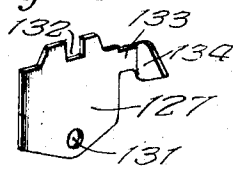


Fig-39



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KNITTING MACHINE

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Fig-40

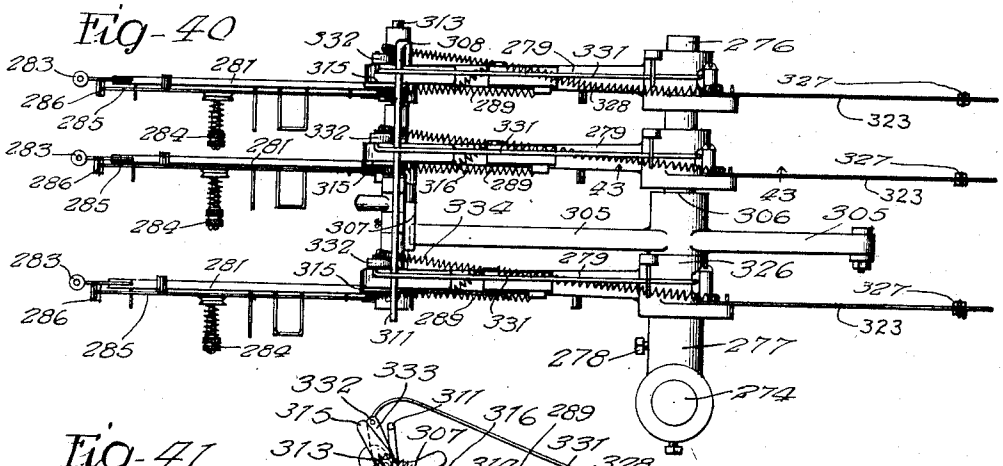

Fig-41

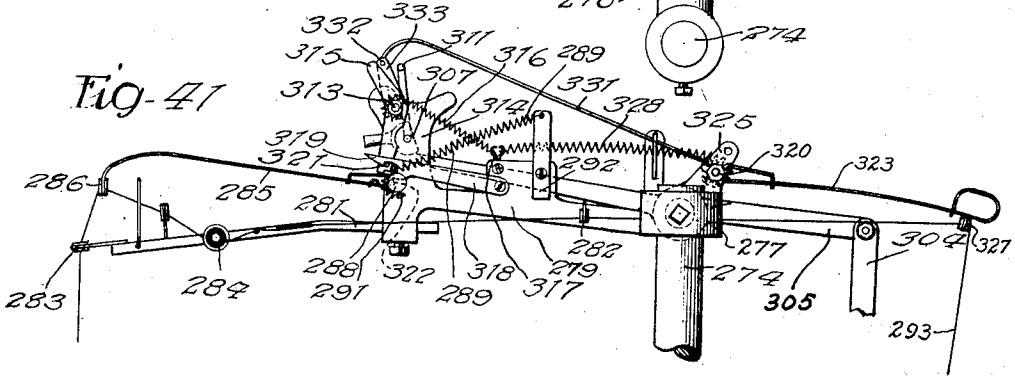

Fig-42

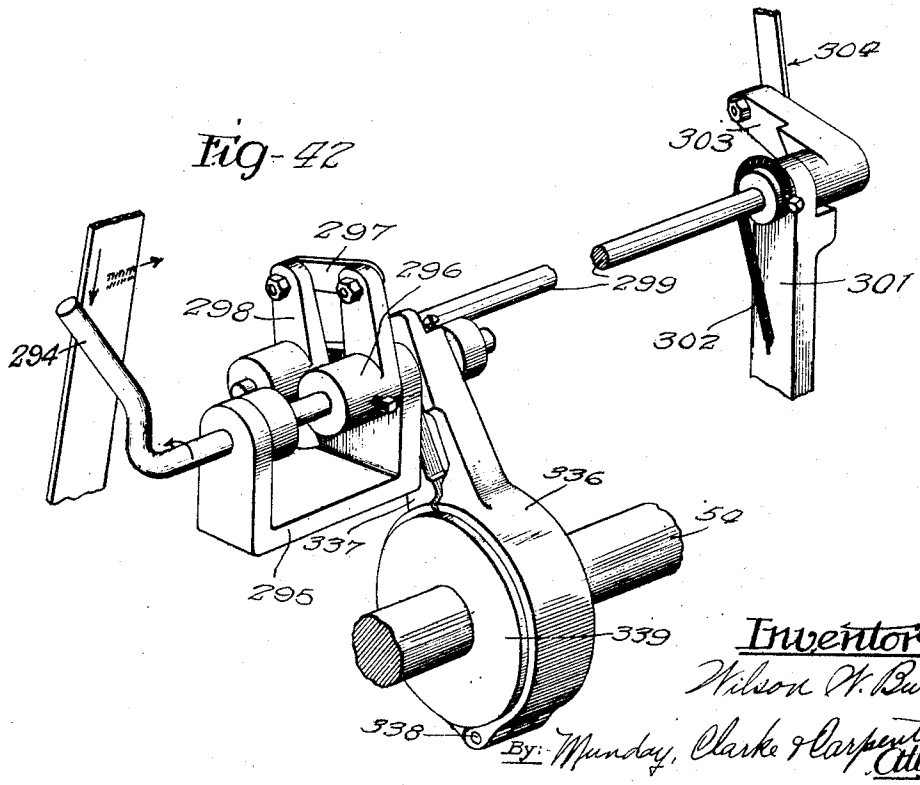

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Fig-43

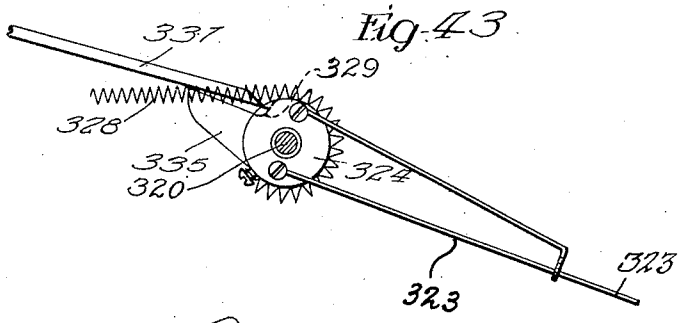
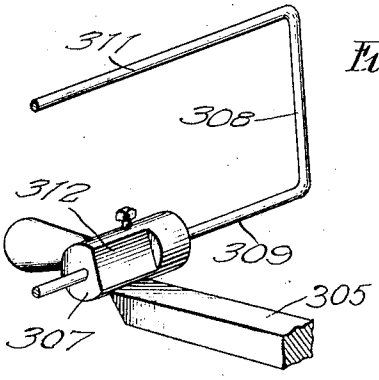


Fig-44



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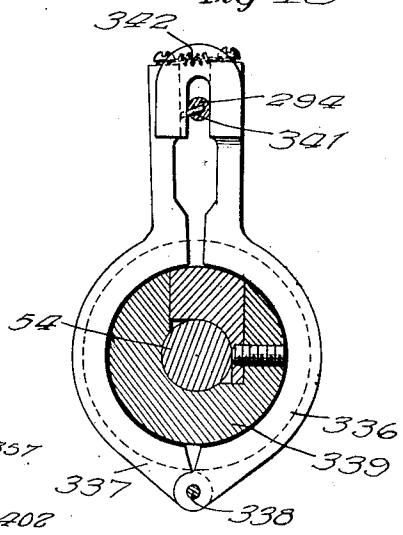
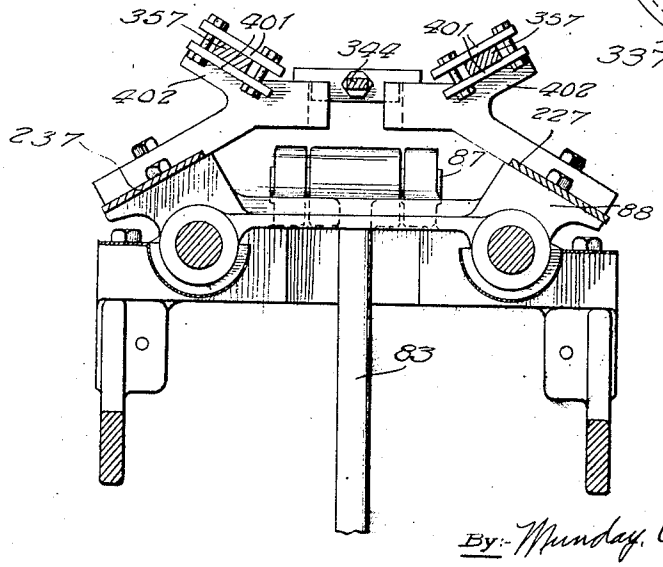


Fig-46



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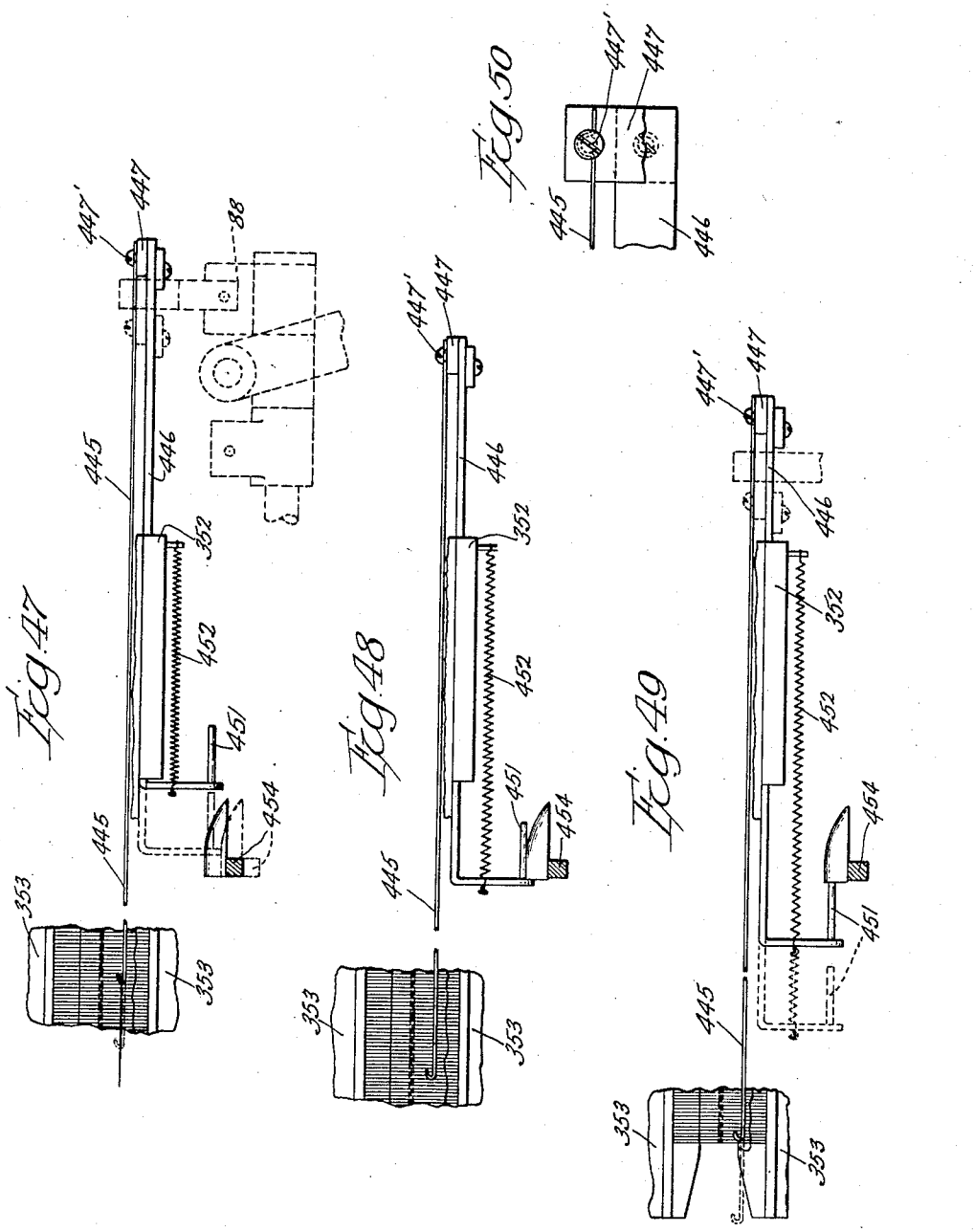

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Fig. 51

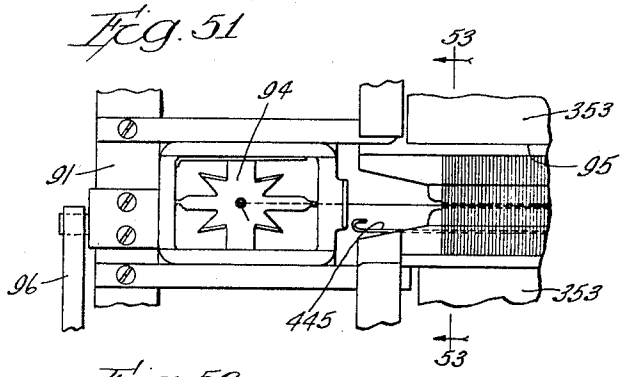
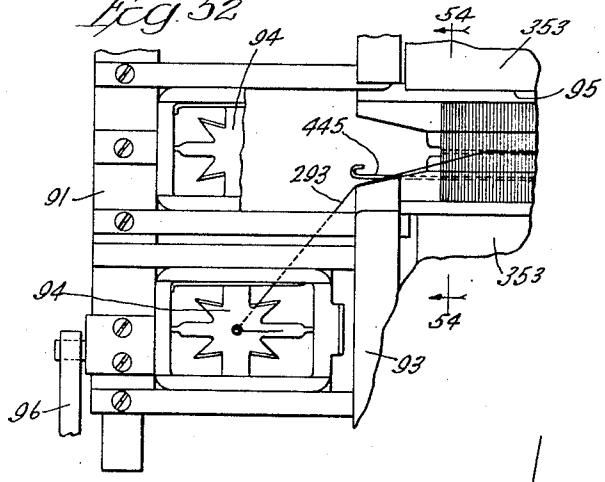


Fig. 52



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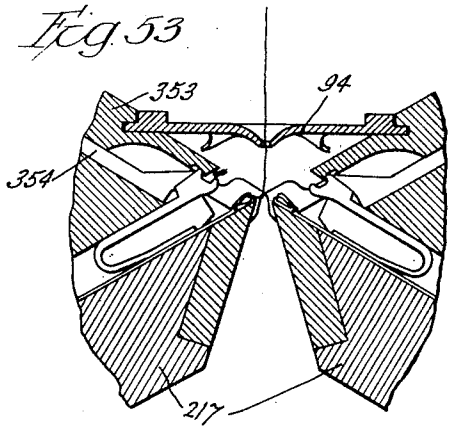
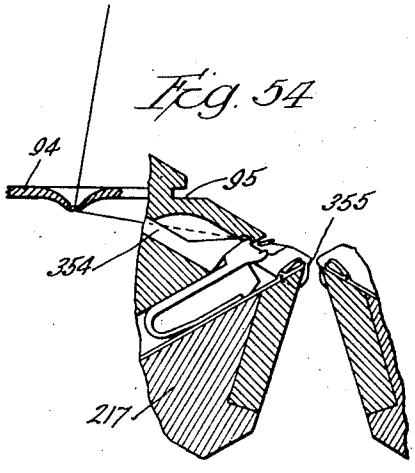


Fig. 54



Inventor:
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Attys.

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Fig. 55

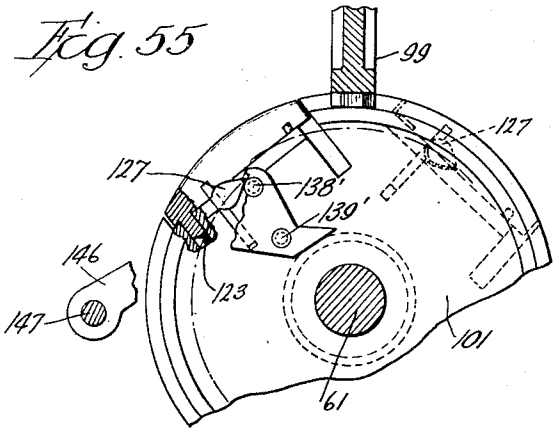
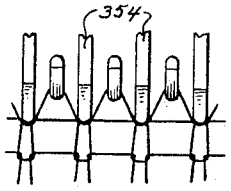


Fig. 56



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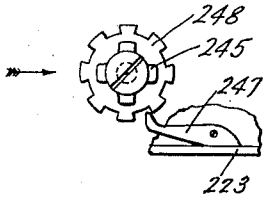

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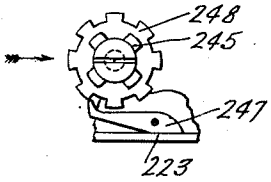

Fig. 59

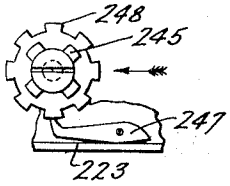

Fig. 60

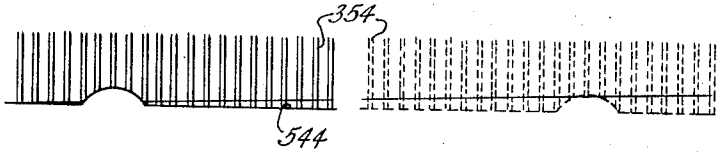

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Fig. 61

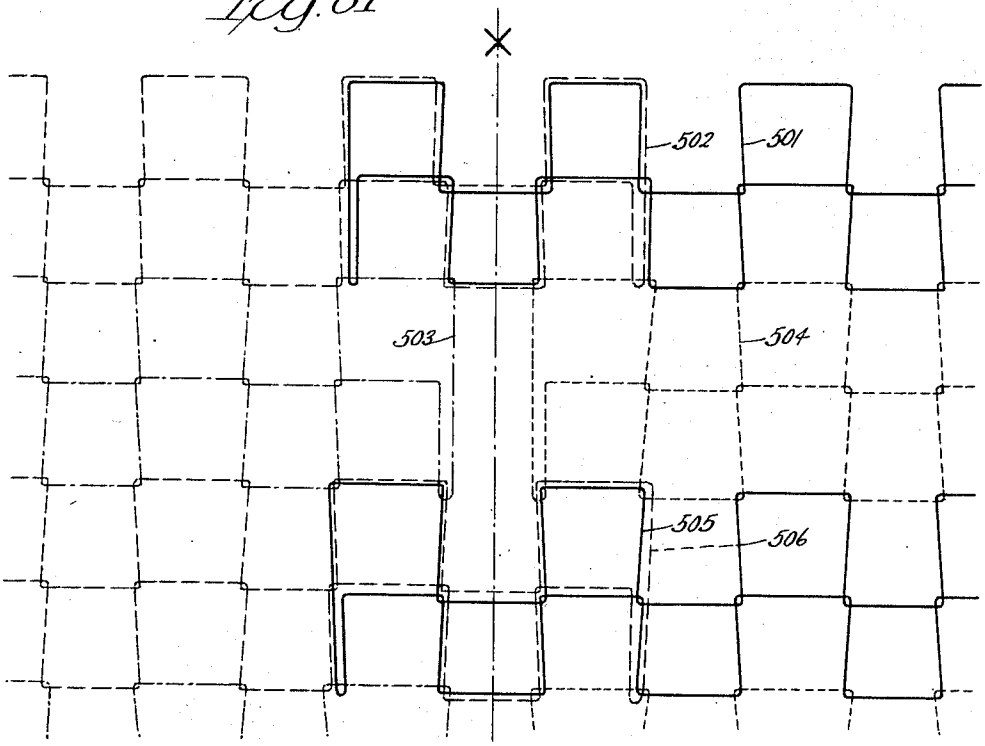


Fig. 62

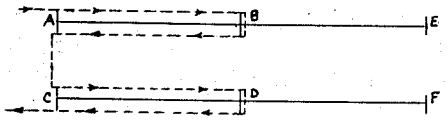
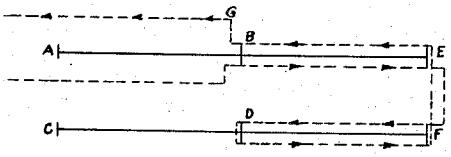


Fig. 63



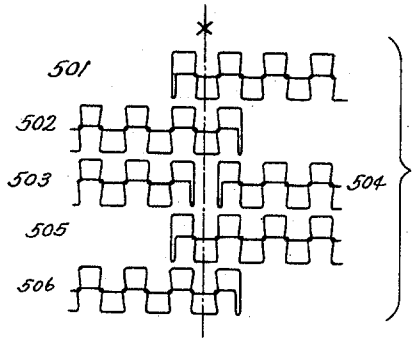


Fig. 64

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Fig. 65

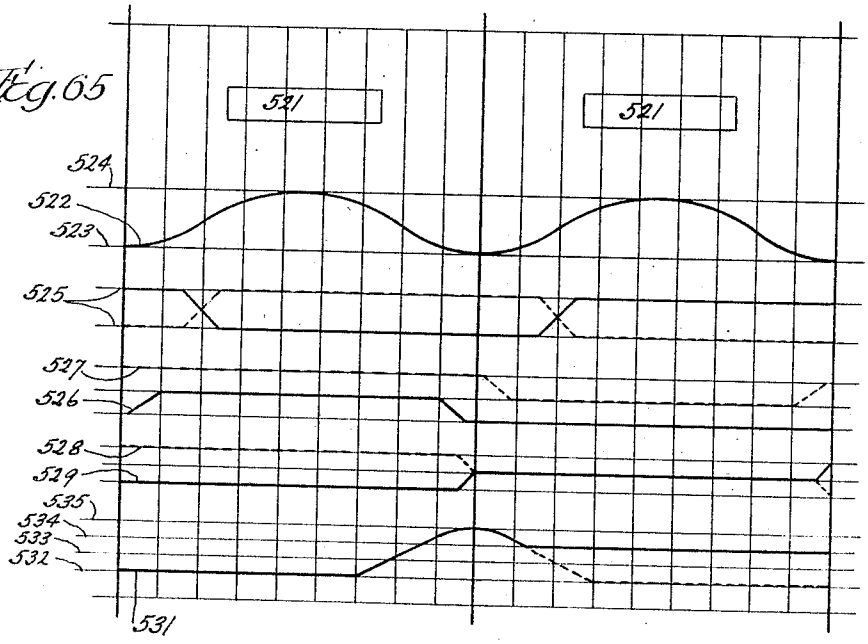
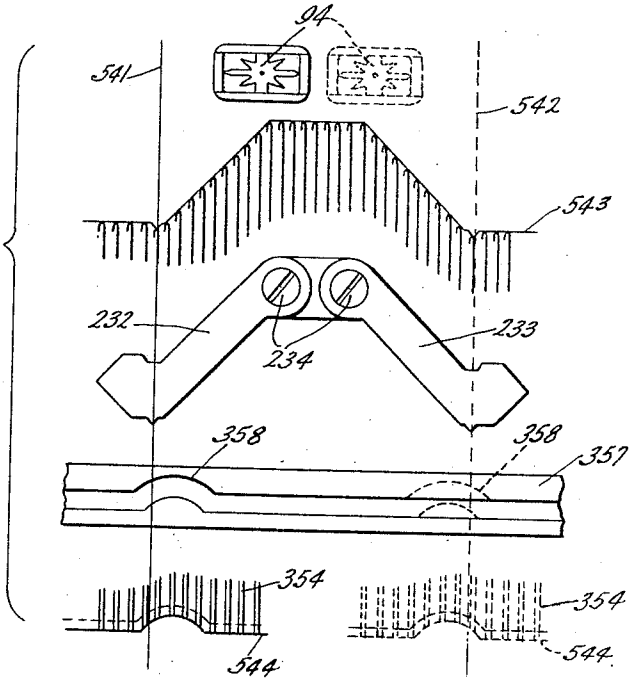


Fig. 66



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Patented Sept. 17, 1929 1,728,661

UNITED STATES PATENT OFFICE

WILSON W. BURSON, OF ROCKFORD, ILLINOIS, ASSIGNOR TO B. Z. B. KNITTING COMPANY, OF ROCKFORD, ILLINOIS, A CORPORATION OF ILLINOIS

KNITTING MACHINE

Application filed February 15, 1922. Serial No. 536,652.

This invention relates in general to knitting machines and while from many aspects it has more particular reference to the machines of the character shown in my earlier Patents No. 944,011 granted December 21, 1909; No. 996,059 granted June 27, 1911; 944,012, granted Dec. 21, 1909; 1,531,272, of Mar. 31, 1925; No. 1,025,182 granted May 7, 1912; No. 1,172,764 granted Feb. 22, 1916; No. 1,201,691 granted Oct. 17, 1916, it will be readily understood that the invention has other and valuable use in machines of other character.

A principal object of the present invention is the provision of a machine of the character of those of my prior patents, of unusually high efficiency, and of entirely automatic action.

Another important object of the invention is the provision of a knitting machine particularly adapted for the knitting of hosiery, and which may be relied upon to produce a fashioned stocking having all of the desired characteristics, as for example a stocking having a lisle toe, sole, heel and top and silk body and with silk in the instep.

Another highly important object of the invention is the provision of a machine of this character which may be readily adjusted by a skilled attendant and which upon being once adjusted may be relied upon to maintain its adjustment and to operate with sufficient certainty of action to permit a single attendant to have supervision over a considerable number of such machines.

Another and highly important object of the invention is the provision of a machine of this character, which will permit of ready adjustment for wide variation in the character of the knitting to the end that varied patterns may be provided.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings,

Figure 1 is an end elevation of a knitting machine embodying my present invention;

Fig. 2 is a partial side elevation thereof;

Fig. 3 is a top plan view thereof;

Fig. 4 is a section taken substantially on the line 4—4 of Fig. 2;

Figs. 5 and 6 are still further enlargements similarly taken;

Fig. 7 is an enlarged detail view showing the relative position and the construction of parts of the machine;

Fig. 8 is a view of the same looking from the bottom in Fig. 7;

Fig. 9 is a section taken substantially on the line 9—9 of Fig. 8;

Fig. 10 is an enlarged fragmentary view of the selecting mechanism for knitting overlapping stitches;

Fig. 11 is a plan view of the same;

Figs. 12 and 13 are sections taken respectively on the lines 12—12 and 13—13 of Fig. 2;

Fig. 14 is an enlarged detail perspective of the mechanism for throwing the cams into and out of action;

Fig. 15 is an enlarged partial plan view showing the yarn storage and selecting mechanism;

Fig. 16 is an enlarged perspective view of the yarn hook for holding the yarn out of action;

Fig. 17 is an enlarged top plan view of a cam carrying bar;

Fig. 18 is a partial bottom plan view thereof;

Fig. 19 is a section taken substantially on the line 19—19 of Fig. 17;

Fig. 20 is a view of a cam eccentric control with the parts disassembled.

Fig. 21 is a top plan view of the loop determining control bar;

Fig. 22 is a bottom plan view of the same;

Figs. 23 and 24 are enlarged sections taken substantially on the lines 23—23 and 24—24 of Fig. 21;

Figs. 25 and 26 are detail elevations of the yarn cut-off mechanism;

Fig. 27 is a section taken substantially on the line 27—27 of Fig. 26;

Fig. 28 is an enlarged perspective view of the bed;

Fig. 29 is a top plan view of the controller;

Fig. 30 is a side elevation of one of the counting wheels;

Fig. 31 is a perspective view of one of the communicating stops;

Fig. 32 is a perspective view of one of the controller disks, parts being broken away to show successive portions thereof;

Fig. 33 is a similar view of the universal controller transfer member;

Fig. 34 is a section taken substantially on the line 34—34 of Fig. 29;

Fig. 35 is a section taken substantially on the line 35—35 of Fig. 29;

Fig. 36 is a section taken substantially on the line 36—36 of Fig. 34;

Fig. 37 is an enlarged detail view showing the switch control;

Fig. 38 is a partial side elevation thereof;

Fig. 39 is a perspective of the switch thrower;

Fig. 40 is an enlarged top plan view of the yarn feeds;

Fig. 41 is a side elevation thereof;

Fig. 42 is a fragmentary perspective view of the power cut-off mechanism.

Fig. 43 is a section taken substantially on the line 43—43 of Fig. 40;

Fig. 44 is a perspective view of the part of the power release operable upon breaking of the yarn;

Fig. 45 is a section taken substantially on the line 45—45 of Fig. 1; and

Fig. 46 is a section taken substantially on the line 46—46 of Fig. 2.

Figs. 47, 48 and 49 are diagrammatic views showing the yarn holding devices in the several positions assumed during the knitting of a garment.

Fig. 50 is a detail view, illustrating a preferred means of connecting the yarn holding hook to the bracket 447.

Figs. 51 and 52 are enlarged fragmentary details illustrating the relative position of the yarn holding device and the yarn carrier, at the end of each knitting stroke, and after a shifting of the yarn carrier has taken place.

Figs. 53 and 54 are sections taken substantially on lines 53—53 and 54—54 in Figs. 51 and 52.

Fig. 55 is a detailed view of one of the gate wheels and showing the relative position of the parts before and after a shifting of the gate has taken place.

Fig. 56 is an enlarged fragmentary detail illustrating the action of the yarn shedding devices during a knitting operation.

Figs. 57, 58 and 59 are fragmentary details illustrating the operation or changes in position of certain parts of the machine.

Fig. 60 is a diagrammatic view illustrating the effect obtained by shifting the cam slide which controls the action of the yarn shedding devices about a pivot to vary the action of the yarn shedding devices.

Fig. 61 is an enlarged diagrammatic view showing the texture of knit fabrics and the preferred form of joining the knit material intermediate the ends of the needle bed.

Figs. 62 and 63 are diagrammatic views illustrating a preferred method of simultaneously knitting two halves of a garment using either yarns of different colors or of different qualities.

Fig. 64 is a diagrammatic view showing the progressive courses required to produce the fabric shown in Fig. 61.

Fig. 65 is a time chart representing the relative movement of the several parts of the machine during one complete knitting cycle.

Fig. 66 is a diagrammatic view showing the relative positions and movement of the yarn carriers, needles, needle cam, yarn shedding devices, and the cam slide for the yarn shedding devices, as assumed during movement of the cross-head which actuates the several parts.

For the purpose of illustrating my invention I have shown in the drawings a completely organized knitting machine in which all of the several features are embodied. This machine is provided with two needle beds, each carrying a set of needles, arranged in inclined positions, in parallel relation and sufficiently close together to permit the knitting to occur continuously up along one side and then back along the other, to form an article (such as a stocking) without a seam and which may be shaped as may be desired by varying the number of needles actually knitting. The thread in a thread-carrier is reciprocated back and forth over the needle beds in position to be engaged by the needles, the needles being projected by pattern mechanism into knitting position, slightly in advance of the forward movement of the thread-carrier, and returned immediately after the passing of the thread-carrier with yarn to be carried through a previously formed loop, which upon the casting off of this previously formed loop forms a new loop retained in the needle.

This machine comprises a frame 51 of any suitable or preferred construction having a base 52 adapted to rest on the floor, and an upper portion 53 carrying the operative parts. A power shaft 54 is mounted in bearings 55 in the upper frame portion 53 and carries, in the present instance, fixed and idle pulleys 56 and 57, the former of which delivers power to the machine. A pinion 58 is mounted on the shaft 54 and meshes with a gear 59 upon a shaft 61 carried in bearings 62 on the frame. This shaft 61 controls and produces through various instrumentalities, to be presently described, most of the actions of the knitting parts with the exception of the knitting movement of the thread carrier, the movement of

the knitting cams, and the movement of the loop-length-determining means.

Referring to Fig. 2, it will be noted that the gear 59 is in effect a crank disk, being connected at 81 with a connecting rod 82 that is in turn connected with a lever 83 fulcrumed at its lower end 84 to a link 85 pivoted at 85' to the base 52 and connected at its upper end at 87 with a cross-head 88 which reciprocates the thread carrier and the cam bars, also as disclosed more fully in my earlier patents mentioned. It is to be noted that the mechanism operating the cross-head 88 is fixed and that the cross-head reciprocates continuously throughout a predetermined and definite travel.

My invention contemplates, among other features of novelty, an entirely automatic control of the movement of pattern members 76 and of the container 91 for the thread carriers for varying the thread used which will be later described (as from silk to lisle, etc.). This control is adapted to progressively advance the pattern members to vary the particular needles projected, to hold said pattern members stationary so that the same needles will be projected on knitting stroke after knitting stroke and to impart to said pattern members alternate forward and reverse movements to present in any sequence desired portions of the pattern members to the needle jack levers.

The invention contemplates also automatic substitutions of yarn at different periods of knitting and the control of the yarn substitution is interlocked with and forms a part of the control of the knitting patterns. Three yarn carriers for substitution are provided. These are indicated by reference character 94 and they are all supported normally in a container 91 (Figs. 1, 2, 3) mounted to reciprocate in guides 92 and 93 arranged at the end of the thread carrier travel in knitting and preferably at right angles thereto. Each thread carrier is provided with an upturned lip 340 with which may be engaged a reciprocating engager 343 (Figs. 3 and 15), secured to the cross-head 88. The engagement permits lateral sliding of the lip 340 across the engager at the thread carrier container so that to change the thread it is only necessary to move the container across the machine to substitute carriers.

The carrier container 91 is connected by a link 96 with a lever 97 in turn connected by a link 98 with the lever 99 which is moved to the right or to the left, viewing Fig. 1, by a gate wheel 101 which will be later described.

A second gate wheel 63 (Figs. 1 and 37) is provided for the control and actuation of the pattern members. This gate wheel 63 is mounted upon the shaft 61 and meshes with a gear 65 upon a shaft 66. This shaft has a pinion 68 which engages a gear 69 on one of the pattern members. The two pattern members are connected for conjoint movement by gear 69 on the one member and gear 73 on the other.

The gate wheel 63 either holds the pattern members in stationary position or causes them to rotate in one direction or the other depending upon the location of parts of the gate wheel as will be later described.

A fixed drum 111 (Fig. 1) is mounted upon the frame beneath the shaft 61 and this drum is provided with a number of control members 112, 113, 114 and 115 (Figs. 29 and 33), and a number of counting members which together form a counter 116, all rotatable about the drum and held in position by a clamping ring 117 secured to the drum 111. Before describing in detail the construction and action of the control members I will first explain the construction, action and control of the two gate wheels 63 and 101 through the agency of which the pattern members and the thread carriers are governed. Figs. 37 and 38 show in detail the construction of the gate wheel 63. Viewing this figure it will be noted that this gate wheel consists of a body 118 upon the face of which is mounted or formed an interrupted circular thread 119. The thread 119 is interrupted preferably at two diametrically opposite points, each interruption being of sufficient width to receive a gate 64, which is or may be adapted to form a continuation of the thread 119 when in central position, or the position shown in Figure 1.

Beneath the gates 64 the surface of the drum is made flat so that the lower faces 122 of the gates may slide smoothly thereon. Each gate is provided with or attached to a pivot 123 taking into an opening in the wheel. A spring 124 that is secured at one end to the end of the pivot 123 and fast at the other end to a stud 125 on the side of the wheel, holds each gate in place or against the flat surface of the drum. A slot 126 is formed through the wheel at each gate and in this slot is positioned a gate swinging member or plate 127. This gate swinging member is held in place by a pin 128 positioned through an opening 129 in the wheel 118 and an opening 131 in the gate swinging member. The gate swinging member is provided with a slot 132 in which the forward free end of the gate rests and also with a laterally extending arm 133, the end of which is bent at right angles to provide a pointed double cam member 134 adapted to be engaged as will be presently described to move the gate in either direction. The cam member 134 for each of the two gates is arranged to extend out at the side of the wheel opposite the other; that is, one is extended from each side of the wheel and a control arm 135 is provided to control one and a control arm 136 is provided to control the other. It will be noted that a yoke 145 is formed in-

tegral with the arm 135 (Fig. 29). This yoke has a free bearing upon a shaft 137, so that the arm will pivot about the shaft, which is or may be suitably mounted in the frame or mounted in suitable brackets attached thereto and arranged substantially as shown. Each of the control arms 135 and 136 is arranged to control one of the gates 64 and preferably is in the form of an arm carrying two pins 138 and 139, these pins being arranged to engage opposite cam surfaces of its companion arm 134 when the arm is moved as will be later explained. The member 136 is fixed on the shaft 137 and has also two pins 141 and 142 similarly adapted for actuation of the cam surfaces of the other gate swinging member. An arm 143, having a guide slot 144, is provided to return the gates to normal position after they have been moved from central position and have accomplished their work.

The gate wheel 101 is similar to the gate wheel 63 except that it has a single gate and a single control member 146 (Fig. 29), which control member is mounted upon a shaft 147 that is or may be mounted in suitable bearings in the frame or in brackets attached thereto and is arranged parallel with the shaft 137. The operation of the gate shifting devices is clearly shown in Fig. 55, which is shown with a single gate wheel such as the gate wheel 63. The solid line position represents the position of the gate swinging member 127 just before this member comes in contact with the pin 138′ to be shifted. The dotted line position shows the gate swinging member after being shifted and after the gate has passed the gate wheel gear, the dash and dot line representing the path of movement of the gate swinging member. From this figure and Fig. 65 it will be noted that the gate is shifted just before coming in contact with the gear and actuates the gear immediately and is returned to normal by means of the arm 143 as best shown in Figs. 29 and 37, before it reaches the pins 138′ and 139′ so that at each revolution the gate may be shifted in either direction by shifting the arm 146 in a corresponding direction, and that when two gates are provided on the same wheel as on the wheel 63, the gates may be shifted to cause a movement in either direction twice in each revolution of the wheel, which represents one complete cycle of knitting, or one stroke of the knitting cams in each direction across the needle bed. It is intended that these gate members will be moved by the rocking of the shafts 137 and 147 and the yoke 145 and through the control mechanism, as will now be described (Figs. 29 and 34.) It will be understood that the gate wheels 63 and 101 rotate continuously with shaft 61 and all movement of the gears 69 and 73 and of the carrier container 91 results from shifting of the gate parts. There is one rotation of shaft 61 for each knitting reciprocation.

Control members for controlling pattern movement

The control members 113, 114 and 115 are caused to rotate successively and at proper times during the knitting of a garment and these control members are adapted to actuate the gate wheels where variation of pattern action and substitution of yarns of irregular, not regularly repeated alteration is desired and the control member 112 is likewise rotated and adapted to take care of repeated like alterations (back and forth movement of the pattern members).

Viewing Figs. 2 and 3 it will be noted that the pattern members 76 are drum shape with the active pattern parts upon their surfaces. Under the action of the gate wheel and its control instead of imparting progressive periodic rotation in one direction as the knitting proceeds I move the pattern members 76 first in one direction and then back in the opposite direction where the pattern arrangement permits. That is to say, the pattern members under the control may be turned in one direction to present successive pattern parts to the needle jack levers and be turned in the opposite direction to knit under the influence of a previously used pattern arrangement. The pattern members may stand still for a part of the time or while the particular pattern arrangement is desired throughout successive knitting strokes.

In the knitting of the stocking, for example, we will suppose that the machine is arranged so that the control members 113, 114 and 115 produce desired and constantly varying changes of pattern and yarn carrier action for a time and then these members are thrown out of action and for a protracted period duplicated alteration of action is produced by the member 112 and that thereafter the garment is finished by further continued irregular action under the influence of the controllers 113, 114 and 115.

For the purpose of operating the control members 112, 113, 114 and 115, a ratchet disk 148 (Fig. 29) is fixed upon the side of each of the controllers 112 to 115 and a pawl assembly for engaging and moving these ratchets is provided. A shaft 160 is hung by arms 160′ from a shaft 149 mounted in bearings 151 (see Figs. 34 and 29). An arm 153 is rigid with an arm 160′ and carries a roll 154 engaging in a cam slot 155 of a cam 156 on shaft 61, the action of this cam being to oscillate the shaft 160 about shaft 149 continuously. The pawls, to be described here and further described later, are hung on shaft 160 to reciprocate over or in engagement with the teeth of the ratchet wheels 148. These pawls include a pawl 157 loosely pivoted on the shaft 160 and adapted for engagement with the ratchet disk of controller 112. A three-toothed pawl 150 is also loosely pivoted on the shaft 160, the teeth of

this pawl engaging the three ratchet disks of the controllers 113, 114 and 115. Still another pawl 158 is pivoted upon this shaft 160 and overlies the gang pawl 150 in position to engage controller 113, this pawl being a straight pawl for commencing the knitting action, as will be later herein described.

Means are provided for alternately holding out of action the pawl 157 which drives controller 112 and the gang pawl 150 for driving controllers 113, 114 and 115 so that either the regular alteration of pattern action under the influence of controller 112 or the irregular alteration of pattern action from controllers 113, 114 and 115 may be employed.

It will be noted that one of the ratchet teeth of ratchet 148 of controllers 113 to 115 is omitted at 159 (Fig. 32) and when such point is located at the top, the controller provided with it is not moved by the ratchet since the ratchet moves idly in the space of this missing tooth. Each of the controllers 113 to 115 is provided with a groove 161 adapted to control the operation of the controller 112. A bar 162 (Fig. 34) upon an arm 163 pivoted at 164 from the frame rests upon three levers 165, (one associated with each of the controllers 113, 114 and 115), each lever being pivoted on a pin 166 and each having a point 167 resting in one of the grooves 161. Within these grooves are arranged recesses 168 (Fig. 32) which when aligned permit depression of the bar 162 and through mechanism to be now described permit action of the pawl 157 and the control member 112. It will be noted that an arm 171 integral with and extending out from the bar 162 is engaged by a lift clip 172 fast on the pawl 157, (Figs. 29 and 34) and that movement of bar 162 controls the pawl 157.

Means are provided through the counting mechanism for stopping the action of the controllers 113 to 115 while the controller 112 is operating and for again starting the controllers 113 to 115 and by this starting throw out of action controller 112 which as heretofore described is accomplished by lifting any one of the levers 165 and as a result lifting also pawl 157. These means include a bar 173 carried upon an arm 174 from a pivot pin 175 (Figs. 29 and 35). Beneath the bar 173 is mounted a plurality of levers 176, each taking in a groove 177 of a companion counting member and pivoted upon pin 166 above the counter. The bar 173 is disposed beneath an arm 179 pivoted upon a pin 181 on the frame, which arm 179 passes beneath a clip 182 fixed to the gang pawl 150, which actuates the control members 113, 114 and 115. In the grooves 177 are provided teeth 183 adapted to move under the levers 176 to raise one or the other of them at the proper time and move out of action the gang pawl, causing the controllers 113 to 115 to remain stationary. These teeth are given the necessary length to cause such period of rest of the controllers 113 to 115 to endure throughout the desired interval.

Operation of gate swinging members

Each controller 113 to 115 is provided with three other grooves 184, 185 and 186 (see Fig. 32), which may be termed the operative grooves and which have in them teeth 187 of appropriate shape and dimension to cause any desired actuation of the three gate swinging members. In the present instance the controller 112 has only two operative grooves as above described, indicated respectively (Fig. 33) by reference characters 188 and 189 (it not being thought necessary in the present instance to operate by the controller 112 both of the gates of the pattern shifting gate wheel).

Considering first the gate control for the yarn changing mechanism, it will be noted that this gate control 146 is mounted upon shaft 147 and that this shaft carries a collar 191, which collar is provided with an outwardly extending lug 192 (see Fig. 36). A yoke 195 is pivoted upon cross shaft or pin 175 (Fig. 34) and is mounted above the four levers 194, each of which has a tooth riding either in its groove 188 of the control member 112 or in its groove 184 of each control member 113 to 115. When one of the teeth in said grooves is brought under one of said levers, rocking of the shaft 147 results and the shifting of the gate wheel from its normal (or central) position is accomplished by means of one or the other of pins 138′ and 139′ that are suitably mounted on the arm 146 and as illustrated (Fig. 55) upon the passing of the cam members 134.

The step-like teeth 187 (see Figs. 32 and 33) of the controllers 112 to 115 inclusive are formed both above and below a central neutral plane on the periphery of these controllers, that is to say, some of these teeth are elevations and some are depressions on the surface of these controllers so that when this central neutral plane is in registration across the controller the gate shifting mechanism is idle. The levers 194, 196, 199 and 167, shown in Fig. 34, are normally held in contact with the teeth by gravity and are raised or lowered from a neutral or non-gate shifting position, the lowering of the levers shifting the forward end of the gate in one direction a distance equal to the circular pitch on the gear 65, and the raising of the levers effecting a like movement in the other direction, causing the gear to advance in one direction or the other in accordance with the pitch of the teeth. Gate control member 135 is movable with yoke 145 (Figs. 29 and 37) and is integral with and operated from a yoke 193 engaging a lug 190 on the yoke 145, the yoke 193 being actuated by the levers 196 taking into grooves 186 and 189 of control members 112 to 115. Gate member 136 is similarly

operated by a rocking of the shaft 137. This shaft carries a collar 197, which is similarly actuated from a yoke 198, which is in turn actuated by levers 199 taking into grooves 185 of controllers 113 to 115. Gate control member 146 is also similarly actuated by a rocking of the shaft 147. This shaft carries a collar 191 similarly actuated from a yoke 195 (Fig. 36) through levers 194 taking into grooves 188 and 184 of the controllers 112 to 115. It will be noted that the teeth 187 of the grooves 188 and 189 (Fig. 33) are uniformly alternating and that the levers 194 and 196 are alternately raised and lowered from the neutral or non-gate shifting position, thus shifting the gates first in one direction and then in the other continuously as long as the member 112 is rotated as previously described.

The counting mechanism

Each of the rotatable counting members or drums 116 is provided with a ratchet 201 (see Fig. 30) from which a tooth is omitted at 202, this ratchet being in addition to the groove member 177. A gang pawl 203, similar to the gang pawl 150 and similarly operated, is provided to drive the counting mechanism and normally rides in registration with missing tooth space 202 of each ratchet disc.

At the end of a knitting operation the last counter to actuate in the knitting of a fabric is provided with means for arranging the controllers for the starting of the next fabric. This means (Fig. 29) in the present instance comprises a pin 204 on the outermost lever 176 engaging an arm 205 extending out from a bar 206 having arms 207 and 208 pivoted on shaft 160 and carrying the pawl 158. This pawl is normally held out of action and when the outer counter member presents groove 177 to the lever 176 the rod is depressed and the pawl 158 drops down into ratchet actuating position.

It will be noted that the pawl 158 projects beyond the companion pawl and engages the ratchet of the controller 113 ahead of the space 202, thus moving the ratchet of controller 113 in the position to be engaged by the gang pawl 150.

With the ending of one knitting operation and the starting of the next, the first counter, i. e. the counter adjacent the controllers, starts rotation, being moved by the lug 210 on the controller to position the tooth back of the missing space of the ratchet disc into position to be engaged by the gang pawl, as will be presently described. Thereafter this counter is rotated step by step under the gang pawl action throughout a whole or a part revolution and until it is instrumental in the starting of the next counter. This next counter proceeds alone in its rotation if the first counter has made a full revolution, or proceeds with the first counter until the first counter makes a complete revolution, and thereafter alone until it starts the next subsequent counter into action. The starting of the one counter from the other is accomplished by the provision of stops as illustrated in Fig. 31. Each of these consists of a plate 209 having a pin 211 adapted to enter into an appropriate recess 212 in the side of the counter. Upon the adjacent face of the adjacent counter is provided a stud 213 arranged for engagement by the plate. The initial movement of each counter resulting from such engagement causes it to come within the zone of action of the gang pawl and to proceed until the space formed by the missing tooth again comes into position to permit idle action of the companion tooth of the pawl in this space. An arrangement similar to that just mentioned is provided between the controllers 113, 114 and 115, these, however, being preferably fixed stops or lugs 210, as indicated in Fig. 32. No provision is made for engagement between the controllers 112 and 113 so that any degree of revolution or number of complete revolutions may be accomplished by the controller 112 without effecting the action of controllers 113, 114 and 115, this being taken care of in the co-ordination of the controller 112 with the counter 116 and through the pawl lifting and lowering mechanism already described. A similar stop arrangement, however, is provided between controller 115 and the first counter so the first counter is moved at the end of the last action of the controller 115 to bring it into action at the end of the knitting of the garment preparatory to proceeding with the knitting of the next garment. The groove in the first counter member is idle for a short arc and continued knitting is subject to the action of the pawl 158 previously described.

The alteration in the counting mechanism to change the size and length of the stocking, where the machine is already arranged for the knitting of the stocking, may be readily taken care of and in order to permit the setting of the machine a lever or arm 214 (Figs. 1, 2 and 29) is pivoted on the center of the drum and from it a post 215 extends in under the counters and carries a normally disengaged sliding pawl 216 which may be engaged with any of the counting devices, as desired, to move any section of the counter ahead to subtract any number of counts from any portion of a stocking and thereby shorten the stocking or otherwise vary the size thereof.

The gate wheel 63 may be set for either direction by either gate wheel control and being thus set in either direction may reverse the motion of the pattern members with resulting economy of pattern space thereon. The double gate is provided in order that, should it be desired, the pattern change may be made at either end of the knitting stroke

and this in the present instance is controlled by the pattern control members 113, 114 and 115 and is not required upon sufficient occasions to justify the arrangement of the controller 112, which is provided to produce a plurality of like alterations, to cause the controller 112 to actuate both controls for gate 63.

The action of the pattern members 76 is to swing the jack levers 77 to lift the jacks from the position shown in Fig. 5 to that shown in Fig. 6. Description of the pattern construction is not believed necessary, it being completely described in earlier Patents Numbers 819,407 and 928,244 in my earlier Patents Nos. 944,011, 944,012, 996,059, 1,025,182, 1,172,764, 1,201,691.

Referring to Fig. 28, reference character 217 indicates the main member of each needle bed, this member is preferably slotted as indicated at 218 to receive separating plates 219 forming partitions between the needles, jacks and levers. End plates 221 are provided and upon these rest two bars 222 and 223 similarly slotted at 224 to engage the top edges of the separator plates 219. These needle beds are mounted in inclined position and a needle and jack and a jack lever are positioned between each pair of separator plates, the jack levers being pivoted upon a cross-rod 226 (see Figs. 5 and 6). The top bars 222 and 223 provide guides for the cam slides 227, which cam slides are shown in detail in Figs. 17 to 20, and in their relation to the rest of the machine in Figs. 5 and 6. Each cam slide is cut away to provide an opening 228 back of which is mounted a pivot plate 229 pivoted at 231 on the top of the slide. Each slide carries two cams 232 and 233 pivoted at their adjacent ends at 234 on the pivot plate 229.

The jacks 78 are provided with slots through which the two cams 232 and 233 pass,—the one to project the needle and the other to retract it (Figs. 4, 5, 6, 17, 18 and 20). The cams 232 and 233 are mounted upon the pivot plate 229 for accurate adjustment. This adjustment is effected by swinging them about the pivot centers 234, which are preferably shown as being at those ends of the cams which are adjacent each other. The cam 233 is locked in adjusted position to the back plate and the cam 232 to a member which is movable to permit adjustment to various loop lengths, as will be now described.

The outer end of each cam is provided with an upward extension (as viewed in Fig. 17) in the form of a shoulder stud 235 arranged in a recess 237 of an eccentric mounting 238, i. e., the recess 237 and the stud are eccentric with respect to the axis of movement of the mounting (Figs. 7, 17, 19 and 5). One said mounting is fixed in adjusted position by a screw 230 taking into plate 229, and the other is fixed in adjusted position by screws 230′ which thread into holes 230″ in a shiftable carrier bracket 239 arranged on the top of the plate 229 and having an offset arm 241 carrying a stud 242. Carrier bracket 239 is formed with a bore 239′, in which fits the correspondingly shaped eccentric mounting 238 having the recess 237 in which fits the stud 235 fixed to the face of the carrier. The end of the arm 241 is oppositely beveled at 243 to be engaged by a spring 244 to hold the arm and mounting in assumed positions. The stud 242 is adapted to be moved upon occasion to shift the position of the cam slightly by a mechanism associated with a separate loop length determining mechanism to be presently described.

The cams travel normally above the nibs of the jack and are depressed by moving down the pivot plate 229 against the pressure of spring 246′ and into position to engage the jacks 78 on active knitting strokes. This is accomplished by a four-toothed wheel 245 carried by the cam slide 227 and located at the side of the pivot plate 229. This wheel is adapted to engage an arm 246 extending out from a bracket secured to the plate 229 (Fig. 5) into position to be depressed by a tooth of the wheel against the pressure of the spring 246′ or to be elevated between the two by the spring 246′ which is or may be suitably mounted substantially as shown and arranged to normally urge the plate 229 in a clock-wise direction about the pivot 231 thereof. Near each end of the knitting stroke a pawl 247 is or may be suitably mounted or arranged for each cam slide as will be later described and a ratchet wheel 249 is fixed with each toothed wheel 245 for engagement with one or more of the pawls upon passing thereover to move the toothed wheel, the position shown in Fig. 19 being knitting position with the cams thrust down for engagement with the jack. It will be noted (Figs. 14, 57, 58 and 59) that the pawls 247 are adapted to actuate the ratchet wheels 249 when they are traveling in one direction only and that the ratchet wheels travel freely over the pawls when traveling in the other direction; that is, when the ratchet wheel is traveling toward the right as indicated by the arrow in Fig. 57, the pawl 247 engages the lowermost tooth and moves the tooth to the position shown in Fig. 8, where the pawl passes from beneath the tooth, and when the ratchet wheel moves toward the left as indicated by the arrow, Fig. 59, the pawl is moved downward against the part 223 of the needle bed and the wheel passes freely thereover. It will be understood that a slight friction is necessary and that the pin upon which the ratchet wheel is mounted is so arranged as to provide this friction. It will also be noted that the movement of the toothed wheel 248 is limited or controlled by the position of the pawl 247 and in the present instance, the end of the pawl opposite the pivot thereof is arranged to limit

the upward movement of the pawl so that it will just pass beneath the first tooth to the right (Fig. 7), engage the tooth at the bottom, and pass beneath this tooth, which is the tooth shown in contact with the pawl (Fig. 8) after the wheel has been moved approximately 45 degrees. One of the pawls 247 being arranged in each end of the needle bed and arranged to engage the wheel 248 when it is traveling toward the needle bed, it is possible to move the wheel 248 once substantially at the beginning of each movement of the needle cams across the needle bed, and that the cams may either be lowered into jack engaging position or lifted out of jack engaging position upon any knitting stroke or stroke of the cross-head 88.

The pawls 247 (Figs. 7, 19, 57 and 59) may be mounted adjacent or on the needle bed in any suitable manner and arranged in any suitable position to engage and actuate the toothed wheel 248 as will now be described, and in the preferred construction, one of the pawls 247 is mounted at each end of the needle bed on each side of the machine and in a position where the toothed wheel 248 carried by each of the cam bars 227 will pass thereover substantially as illustrated in Figs. 57, 58 and 59, just prior to its extremity of movement in either direction so that at each end of a stroke of the cam bar 227 the knitting cams carried by the plate 229 may be moved either to or from a needle actuating position. Each pawl 247 is or may be secured to an end of a shaft or rod 251 that is arranged to extend through a part 223 of the needle bed and to receive a lever 252 (Fig. 14). The rod 251 being rotatably mounted in the part 223, a spring 253 that is or may be attached to the part 223 substantially as shown is arranged to engage an end of the lever 252 and to urge the lever in a counter clockwise direction (viewing Fig. 14). A sleeve 255 which is rotatably secured to the part 223 of the needle bed adjacent the rod 251 by means of a shoulder screw 255′ or the like, is formed to provide a laterally extending lug 254 of sufficient length to engage beneath the lever 252 and a similar arm or lug 256 extending laterally therefrom and preferably in a direction opposite the lug 254. A lever 258, which is preferably formed of sheet metal and pivoted on the rod 226, which also provides a pivot for the needle jack levers 77, substantially as shown. One end of the lever 258 is formed to provide a slot 257 that is adapted to receive the arm or lug 256 on the sleeve 255. The other end of the lever 258 is suitably formed to engage the periphery of a cam disc or wheel 259, and to be moved thereby about its pivot on the rod 226. A spring 261 that is or may be suitably attached to the lever 258 and to the part 223 of the needle bed substantially as shown, or in any suitable manner, is provided to hold the end of the lever 258 in contact with the cam disc 259. One of the cam discs is or may be attached to or mounted on each of the pattern members 76 and at or near each end thereof, so that each of the pawls 247 may be separately controlled in accordance with the contour or peripheral form of the cam disc 259. The periphery of the cam disc 259 may be formed to provide teeth or recesses or both, so as to cause a change in the position of its pawl 247 at any time during a knitting operation. While I have shown the disc 259 arranged to move the pawl between two fixed positions, it will be understood that other positions or movements of the pawl may be had if desired, by forming the periphery of the disc 259 in accordance. In the present embodiment, the spring 261 causes the end of the lever 258 to follow the contour of the cam and when a depression or tooth is presented at the end of the lever, as shown (Fig. 14) the pawl is held in position to engage a tooth of the toothed wheel 248 to move the wheel about its bearing when the wheel passes the pawl travelling toward the right (Figs. 57 and 58) and when the wheel passes the pawl traveling toward the left (Fig. 59), the pawl is moved about the axis of the rod 251 against the action of the spring 253. When a projection or tooth on the cam disc 259 is presented against the end of the lever 258, the shaft 251 is rotated by means of the sleeve 255 and the lever 252 to hold the cam down in the position shown (Fig. 59), which permits the toothed wheel 249 to pass over the pawl freely in either direction. By manipulating the pawl in this manner the needle actuating cams may be projected to knit upon the next stroke of the cam bar 227, or may be thrown out of action as desired.

The present embodiment of my invention is arranged to knit stockings having what is commonly termed lisle toe and heel, and a split foot; that is, the lower portion of the foot being lisle and the upper portion of the foot being silk or other material, and a top of silk or other material. In order to knit the split foot or the part where the sole is of one material and the top of another, it is necessary or advantageous to progressively knit the two halves or sole and top, and simultaneously join them together. The portion of the stocking immediately above the heel is similarly knit, except that the same kind of yarn is used on both halves, the one on the back of the stocking being heavier than the one on the front, on account of the wear at this point. To accomplish this I have arranged the machine to begin knitting at an end of the needle bed, as indicated at A, Fig. 62, and knit to a point B, which may be any point intermediate the ends of the needle bed, then back to A, crossing to the opposite side of the bed to C, and knitting to D, and then knitting back to C. This may represent either the top or the bottom half of a stock-

ing. The yarn used for this knitting is then thrown out of action and another yarn is substituted therefor with which knitting is commenced at B, as shown (Fig. 63). This yarn is knitted to E, crossing to the other side of the bed to F, then to D, then returning to F, crossing back to the original side of the bed, then to B and out. If both of the yarns be continuously knit, it will be noted that the knitting will be connected at C and A, so as to form one half of a stocking, since the same yarn that passed out at C re-enters at A. Likewise, the yarn that is used for the opposite half of the stocking returns again at B and repeats to form the other half of the stocking. If the points B and D represent one or more needles, there will be an overlapping of yarn at each course of knitting and a prominent seam would be formed at the joint. If the points B and D represent a position between two needles, there would be no connection between the two halves. I prefer to arrange the machine so as to overlap on one course of knitting and not to connect on the next, so that the joint will be formed by alternate overlapping and open courses as illustrated (Figs. 61 and 64) as will be later described. This is accomplished by manipulation of the pawls 247 and the pattern number 76 to control the position of the needles so that the knitting will be accomplished as above mentioned.

From the yarn feed and control members, to be later described, the yarn extends downwardly directly into the yarn carriers 94 each of which constitutes a slide movable in the guides 95, the guideways of the container 91 forming a part thereof when in register. From this container a particular yarn carrier is engaged by a yarn carrier engager 343 (Figs. 3 and 15) connected by connecting rod 344 with the cross-head, it being understood that these yarn carriers are engaged by the yarn carrier engager as they are presented in registration with the guides 95 and are reciprocated until changed by the yarn changing mechanism. At the end of each forward reciprocation, the yarn carrier enters into the presented empty guideways in the container 91. When the yarn carrier has been thus positioned the container may be shifted to present a different yarn carrier for the next knitting action. It will be noted that a ledge 340 is arranged on the end of the yarn carrier for transverse sliding engagement with the yarn carrier engager 343 (compare Figs. 3 and 15).

Loop length determination

In the apparatus shown in the drawings means are provided for determining accurately the length of the loop formed in the knitting operation. It will be understood that the needles are of the latch type and when projected permit the loop previously knit to slide back along the needle when held, opening the latch and permitting the needle to pick up the yarn to form a new loop. Return movement of the needle causes the latch to close with the resultant shedding off of the old loop over the yarn picked up, the yarn thus remaining in the needle by this action forming the new loop. I provide means in the present instance to move down on each side of this new formed loop to push down the old loop and thus determine the length of the new loop by the extent of this pushing action Figs. 56, 60 and 66. Guide members are mounted above the needle bed and consist of a base plate indicated by reference character 351 (Figs. 4, 5 and 6) and top plates 352 and 353. These plates are arranged with slots for reciprocating slides 354, one of which is arranged between each pair of needles and it has at its forward end a recess 355 for engaging the cast-off yarn. The upper end of each slide is provided with a nib 356 adapted for engagement in a sliding cam bar 357. This cam bar is shown in detail in Figs. 21 to 24. Fig. 22 shows a bottom plan view of the slide cam 357, from which it will be noted that this cam has a single retraction part 358 adapted to lift the slides 354 slightly in advance of the instant of knitting and to return the slides to loop determining position when the yarn is in best condition for this measurement to occur as described in connection with the timing of the machine. This is at the instant when the old loop is shed off (Fig. 5) so that in this machine the slides 354 actually render the shedding off a positive action.

The cam slides 357 are extended back and connected to the cross-head at the rear and this connection is preferably a lost motion one which will permit of alteration of the relative position of the cam slides upon the forward and return knitting stroke. The rear end of each slide 357 is provided with two cleats 401 arranged on opposite sides of a cross-head bracket 402 (Figs. 2, 3 and 46) on which the rear end of the cam slide rests. The cross-head 88 is reciprocated by arm 83 to drive slide 357 through the cross head bracket 402, which is or may be attached to the cross-head in any suitable manner and the cleats 401 that are fastened to the slide 357 on opposite sides of the cross head bracket and formed to abut thereagainst as shown in Fig. 2. These cleats are positioned apart appropriate distances to have the loop determining action occur with the same lag behind the needle projection in knitting in each direction across the needle bed.

The plate 352, in which the slide 357 moves and is guided (see Figs. 4, 5, 6, 21 to 24 inclusive) is pivoted at 359 to a bracket 361 so as to swing about the pivot 359 (see Figs. 3 and 21) in a plane parallel to the plane of

movement of the pushers 354 (see Fig. 4) whereby to vary the operative stroke of the pusher for controlling the knitting tension, as hereinafter more fully described. This plate 352 is also loosely connected to this bracket, this loose connection consisting of a plate 363 formed on the bracket (see Fig. 12), which engages in a slot in the plate 352. A spring 364 normally tends to separate bracket and plate 352. In order to reinforce the connection between the slotted plate 352 and the plate 363 which projects into the slot to the plate, said plate 363 is formed with a cutout shown in dotted lines as 362 (see Fig. 21). A screw 362′ passes through the top of plate 352 through the cutout 362 in plate 363 and then into the lower portion of plate 352. When plate 352 is shifted about its pivotal axis 359 the screw 362′ rides freely in cutout 362. Two threaded studs 365 extend from the bracket and are secured to a cross-shaft 366, which is supported by two connectors 367 fast on a shaft 368, which is pivoted in supporting brackets 369 (see Figs. 2 and 12). This shaft is adapted to be oscillated to vary the length of the loop as the particular conditions of knitting may require from time to time in the formation of the garment.

An arm 371 (Fig. 12) is fast on the shaft 368 and extends down to three cams 372 (Figs. 2 and 12). The arm 371 carries three set screws 373, 374 and 375, respectively positioned above three levers 376, one arranged over each cam disk and having a tooth 377 adapted to engage the face of the cam disk and be lifted thereabove by teeth 378 formed on the periphery of each companion disk. The three set screws 373, 374 and 375 may be set to different heights so that each cam disk will give a characteristic loop length under the action of the slide. An extension 379 of the arm extends over the bed part 221 and a set screw 381 is mounted in this arm to provide for accurate arrangement of the slide 357 when not acted upon by the cam disks 372, a spring 380 (Fig. 2) normally holding the set screw 381 in contact with the bed part 221.

It sometimes happens that it is desired to knit longer loops on one end of the knitting stroke than on the other. This occurs for example in knitting the foot of the stocking or where, as has already been explained, the material is knit across one half of one side of the needle bed, around across one half the other side, and then back to the starting point, the other material being similarly knitted on the other parts of the needle bed for the sole. To accomplish this I provide for swinging the cam slide 357 about its pivotal axis at 359. A bracket 382 is secured beneath an end of the slide (the right in Figs. 23 and 24) and this bracket is adapted for engagement by a downwardly extending lip 383 upon a pivot member 384 carried on a pin 385 extending out from the bracket 361. A cam engaging member 386 is also pivoted on this pin 385 and adjusted with respect to the member 384 by a set screw 387. The cam engaging member 386 rides upon a cam 388 formed on an arm 389 (Figs. 13 and 24) extending up from a lever 391 pivoted on rod 226, already mentioned. The upper end of the arm 389 is loosely connected at 392 with a collar 393 upon shaft 368. The lever 391 is provided with a tooth 394 engaging a cam disk 395 mounted with each pattern member 76 so that actuation of the cam disk produces a swinging movement of the guide bar 352 and slide cam 357. A spring 390 that is or may be suitably attached to the frame 53 substantially as shown (Fig. 2) causes the lever 391 to follow the cam 395 (Fig. 13). This action is accompanied by the partial rotation of the needle jack cam 233 through the eccentric mounting 238 illustrated in Figs. 17 to 20 and already described. The pin 242 is adapted for engagement by a pin 396 having a wedge or double-beveled face as indicated in Fig. 13. This pin is mounted with the collar 393 pivoted on the shaft 368 and is adapted to be swung thereby to one side or the other of the pin 242 to move it in one direction or the other upon the passing of the pin 242 which is carried by the slide 227 as previously described. An arm 397 on collar 393 extends out for engagement by stop pins 398 and 399 that are or may be suitably located in the needle bed or frame to limit the movement in each direction.

In knitting the foot of a stocking where the knitting is from intermediate the ends of one needle bed to intermediate the ends of the other, then back to the starting point, and with one type of yarn, then substituting yarn and knitting the other half of the garment, beginning at an end of the bed, knitting to the point where the material previously used ends, back to the end of the bed, down along the other side of the bed, and back out, as illustrated in Figs. 62 and 63; that is, knitting from the point B to E and F to D, and back again from D to F and E to B (Fig. 63), then knitting from the point A to B, B to A, C to D and D to C (Fig. 62). I have found it desirable to overlap certain courses of knitting as previously mentioned, at the points B and D which may represent any point intermediate the ends of the needle bed, and not connect the knitting on other courses, to prevent the formation of a prominent seam or joint, as illustrated in Figs. 61 and 64. To illustrate, a course of knitting 501 on the right hand side of the bed is carried one stitch beyond the center of the joint, which is represented at X, and indicates a point between two needles, and may be located at any point intermediate the ends of the bed. Another course of knitting 502 from the left hand side of the bed is also carried one stitch beyond the center of the joint. Courses 503 and 504 do not cross the center and courses 505 and 506

are duplications of courses 501 and 502. These courses are shown super-imposed in Fig. 61 or as knit. To aid in following the several courses, different types of lines have been used and upon referring to this figure it will be noted that the yarn is double on the two central or joint needles, where the courses 501 and 502 come together, and single where the courses 503 and 504 come together. A preferred form for accomplishing this result will now be described that includes means separate from the pattern members 76 for projecting the desired number of needles, which may be one or more, independent of the pattern member 76. These means are best shown in Figs. 7 to 11 inclusive, and in the present instance they are arranged to project or cause the projection of one needle on each side of the center line of the joint. They are preferably located approximately at the center of the needle bed, and as previously mentioned, may be arranged at any desired point intermediate the ends of the needle bed. The pattern members 76 are arranged so that in one position they will lift the jacks of all of the needles or any desired number of needles on one side of the center line of the joint, so that when they are shifted one point through the mechanism previously described, they will project the desired number of needles on the opposite sides of the center line of the joint, so that by shifting the pattern member alternately forward and backward, the machine will knit courses like the courses 503 and 504 (Fig. 64); that is, coming together at the center, but not overlapping. A plunger 403 mounted in a bearing 404 on the needle bed member 223 is arranged to engage the ends of the two needle jack levers 77 that control the needles on each side of the center line of the jacks, so that when it is desired to overlap the material or knit the courses 501 or 502, the plunger is forced downwardly and lifts the jack lever of the needle that is not thrown into operative position, or lifted by the pattern mechanism, so that the next knitting course will be extended beyond the center of the joint and the knitting will overlap as illustrated in Fig. 61. While any suitable means may be provided to actuate the plunger 403, I have shown a preferred form of mechanism for accomplishing this result, which includes a head 405, forming a part of an arm 406 which is pivoted as at 407 to a bracket 407′, which is or may be suitably secured to the member 223 of the needle bed. A spring 408 is suitably attached to the bracket 407 and arranged to normally lift the head 405. A cam member 409 is pivotally connected to the head 405 as at 411 (Figs. 7, 10 and 11) and arranged to move through the head substantially as shown. A spring 412 which is preferably of the leaf spring type is arranged to urge the cam member 409 toward the position shown (Fig. 11), and a latch 413, that may be of any suitable form, is arranged to engage in a slot 414 in the cam member 409, to lock the cam member in a neutral or inoperative position, which is the position shown in Fig. 10.

The latch is relieved at proper intervals by a lever 415 (Fig. 7) pivoted at 416 on the frame and having an end 417 adapted for engagement by a lug 418 on the gear of the pattern member. Lever 415 is connected by a slotted link 419 with the latch, a shoulder stud 421 being provided to guide the slide link in its action. The link 419 may be formed as a part of the latch 413, or attached thereto in any suitable manner. When the lug 418 engages the projection 417 of the lever 415 the lever is moved in a counter clockwise direction (viewing Fig. 7) against the force of a spring 410 and the latch is withdrawn with resulting movement of the cam member from the position shown in Fig. 10 to that shown in Fig. 11. Thus arranged the latch 409 is adapted for engagement by a member 422 carried by the needle jack cam slide, and as will now be described.

It will be understood that the member 405 (Figs. 7, 8, 9, 10 and 11) is arranged over the top of plunger 403 and to engage and depress the plunger as seen in Fig. 9. The free end of the cam member 409 is beveled as indicated by shade lines in Fig. 11. The member 422 on the slide 227 travels alongside the head 405 on each stroke of the cross-head during knitting movement and so that when the parts are arranged as shown in Fig. 11 the cam end of 409 is in the path of travel of this member 422. Traveling toward the left in Fig. 11, a pointed part of the cam member 409 engages beneath the member 422 and the member 422 engages the cam face of the member 409 and in passing thereover it thrusts down the head 405 around its pivot 407 to the position shown in Fig. 9 with resulting movement of the jack levers to present the needle jacks in cam engaging position. In reciprocating toward the right (viewing Fig. 7) this member 422 pushes (viewing Fig. 9) the cam member 409 about its pivot or toward the left to permit the latch 413 to engage in the recess 414, if the latch 413 is in latch engaging position. If not, the cam member 409 returns to the position shown in Fig. 11 to repeat or again cause projection of the needles and is engaged by the end of the member 422 to lift the needle jacks upon the return stroke as above described. A pin 423 is positioned through the needle bed member 223 to bear upon the jack levers and a spring 424 arranged to bear upon the top of the pin 423 causes the jack levers to return to their normal position after this actuation.

Yarn cutting and holding mechanism

Means are provided in the machine disclosing an embodiment of my invention for

cutting and holding a yarn when it is no longer desired in the making of a particular garment. These means are shown best in Figs. 25 and 26. A lever 431 is pivoted at 432 and engaged at one end by a bifurcated end 433 of a lever 434 bent to extend over one of the gear wheels 69 in position to be engaged and swung by a lug or pin 435 when shearing is desired. Lever 431 is provided at one end with a hook 436 through which the yarn is fed when the yarn carrier is moved into and to the right (Fig. 1) in the yarn carrier container. Upon the top side of the lever a plate 437 is pivoted at 438 on the lever and is provided with a pin 439 engaged in a slot 441 of a bracket arm 442 fixed beneath the lever. This plate 437 has a cutting edge 443 (Fig. 27) adapted to co-operate with the top surface of the hook 436 to shear the thread. The lever 431 moves close to a back plate 444 and when drawn down acts to clamp the cut end of the yarn between it and the hook to hold it in the yarn carrier until knitting of this yarn recommences. The co-operating edges of the back plate 444 and the hook are rounded so as not to shear the yarn at this point. The cut end passes freely through the needle bed and is partly interknitted with later knitting to present ravveling.

Means are provided in this apparatus for holding a yarn connected with the knitted garment out of the way while another yarn carrier is supplying the material being knit. This means comprises a wire hook 445 (Figs. 15 and 16) carried on a slide 446. The hook 445 may be suitably secured to the slide 446 by means of any suitable clamp 447 or the like, the clamp 447 being secured to the slide by means of a screw 446′, and the body of the hook is preferably bent to embrace a screw 447′ and secured against the top surface of the clamp by the screw substantially as shown in Fig. 50. The slide 446 is mounted in a guide member 448 secured to the underside of guide plate 353 and at the left-hand end thereof (viewing Fig. 3). Slide 446 is bent down at its forward end at 449 and provided with a pin 451. A spring 452 fast to the block 448 at one end and to a hook 453 on the slide at the other tends to retract the slide as may be observed in Fig. 16. A lever 454 pivoted upon the rod 226 is adapted for engagement with the pin 451 or with the slide itself, and to permit both to pass upon occasion. The opposite end of this lever is bent over at 455 to rest upon one of the levers 376. The end of the slide 446 projects within the zone of movement of and is adapted for engagement at each reciprocation by a part of the reciprocating cross-head 88, thus moving the slide and the hook member a predetermined distance at each stroke of the cross-head 88.

The slide 446 and hook 445 normally rest in the position shown in Fig. 47, the clamp 447 being formed to extend into the path of movement of the cross head 99 so that at each reciprocation the cross head will move the slide and hook to the position shown in dotted lines in Fig. 49. In this position the hooked end of the hook extends out at the end of the needle bed into the position shown in Figs. 51 and 52. At the same time that the hook is in this position it will be noted that the yarn carrier 94 in use is projected into the yarn carrier retainer as shown (Figs. 51 and 53). If at this time it is desired to change the yarn, the yarn carrier retainer is shifted to present a new yarn carrier for knitting and move the previously used yarn carrier into the position shown at the bottom of Fig. 52, and to the left in Fig. 54. When the yarn carrier with the thread attached to the garment intermediate the ends of the needle bed is shifted to the position shown in Figs. 52 and 54, the yarn is drawn across the hook as illustrated or from the position shown in Fig. 53 to the position shown in Fig. 54, so that when the hook is retracted, the yarn will be caught by the end thereof as shown (Fig. 15). When the cross head starts on the next stroke, the hook and yarn carrier simultaneously follow the cross head in substantially the relative position shown in Fig. 51, until the hook is blocked by the lever 454, while the device may be arranged to hold the yarn at any desired point or number of points intermediate the ends of the needle bed by adding more pins 451 of various length and changing the periphery of the disc 372, by which the lever 454 is actuated. In the present instance I have shown the device arranged to block the hook and consequently hold the thread in three positions, one of these positions being a point substantially at the center of the bed as shown in solid lines, Fig. 47, another position as shown, Fig. 48, which may be any desired position between that shown in Fig. 47 and the end of the bed, and the position shown in solid lines in Fig. 49, which is at the end of the bed or adjacent the last needle, the position at which the hook will come to rest being determined by the position of the lever 454. When the slide is moved to the left (Fig. 47) by the cross head 88, the lever 454 is moved out of the way of the slide 446 when the slide engages the cam shaped end of the lever as illustrated by the dotted line position shown (Fig. 47). If the disc 372 is arranged to permit the lever to return to the position shown in Fig. 49, upon the return of the slide 446 the lever 454 will engage the end of the pin 451 and arrest the movement of the slide at this point. If the lever 454 is so arranged as to miss the pin but to engage the bent end of the slide, movement of the slide will be arrested in the position shown (Fig. 48). The slide 446 is constantly

urged toward the right (Fig. 47) by the spring 452. By this arrangement it is possible to hold a yarn not in use out of the way of or parallel to the needles at one or more points intermediate the ends of the needle bed, which is highly desirable when knitting the so-called split foot or other portions of the stocking where substitutions of yarn such as previously described in connection with Figs. 61 to 64 inclusive or the like, is required. It will be noted that in the present arrangement the hook is projected to release or receive the yarn once during each complete cycle of movement of the cross head 88, and that while the yarn is not constantly held in the position shown (Fig. 15), that is, at right angles to the garment or parallel to the needles, it is always in such position whenever the needles at that point are operated, since the hook can only be moved by the cross head after the yarn carrier and needle cams have passed this point. This will be more clearly understood in connection with the time chart showing the relative periods of occurrences throughout one complete cycle of operation (Fig. 65), which will be later described.

While the knitting of certain parts of the stocking, such as the foot, has been previously described herein, as progressing by knitting from intermediate the ends of the needle bed, along one side of the needle bed, across and along the other side of the needle bed to a corresponding point intermediate the ends of the needle bed, and then back along this side, and along the first mentioned side of the needle bed to the starting point as illustrated in Fig. 62, and similarly and oppositely as illustrated in Fig. 63, after a substitution of yarn, to knit the foot of a stocking having a top part, of one material, and a sole of another material, the machine is readily arrangeable for other starting points, to produce various patterns, such as alternate, full or half courses of varied material and colors, or knitting any desired combination of ornamental design pattern which may be in various colors.

The means for feeding the yarn to the knitting needles will now be described and it may be mentioned at this point that these means include provision for stopping the machine upon binding of the yarn or upon its breaking or other failure of supply. An arm 271 extends back from one side of the front part of the frame and carries provision for a plurality of spools 272, four such spools being shown in Fig. 3. The arm 271 (Fig. 1) is preferably a rod mounted in a clamp 273 upon an upright post 274 in a bracket 275. Post 274 (Figs. 40 and 41) extends up to above the top of the machine and carries a horizontal shaft 276 mounted at one end in a bracket sleeve 277 on the top of the post 274, the shaft 276 being held against rotation in the sleeve by a set screw 278. A number of rigid bracket arms 279 are fixed on the shaft and from the forward end of each of these a supplementary bracket arm 281 extends forward over the needle bed. Eyelets 282 and 283 are provided respectively upon the bracket arms 279 and 281 to form guides for the yarn and a yarn tension device 284 is provided upon the arm extension 281. Associated with this yarn feeding mechanism and forming a part of it are various devices which, if disturbed from their normal position cause the power to be shut off from the machine and a brake to be applied. The control member for the power shut-off and brake mechanism consists in the present instance of a lever 305 upon the rod or shaft 276 which lever is normally held in the substantially horizontal position shown in Fig. 41 and which is released through failure of the yarn, the binding of its tension, the breaking of it, and failure of supply as will be described later.

The lever 305 is connected by a link 304 with an arm 303 upon a shaft 299 mounted in the bearing 301 at the right hand side of the machine, viewing Fig. 1, and in a yoke 295 at the opposite side. A spring 302 (Fig. 42) pulls the arm 303 downwardly when the lever 305 is released.

The shaft 299 carries a second arm 298 which is connected by a link 297 with an arm 296 on a belt shifter rod or shaft 294 having bearings in yoke 295, the end of which is bent up to mechanically shift the belt from the fixed to the loose pulley.

A brake mechanism is arranged on the shaft 54 and this consists in the present instance of a drum 339 on the shaft 54 and two clamping brake members 336 and 337 pivoted together at 338 (Fig. 45). The brake members 336 and 337 extend up from the shaft and embrace between them an end of the belt shifter shaft 294. A spring 342 pulls the braking members into brake applying position and a leaf or pin 341 set in shaft 294 acts to open the brake members and permit unobstructed rotation of shaft 54 when the belt shifter is in its normal inoperative position. It will be thus apparent that whenever the lever 305 is released from any cause the belt will be shifted from the fixed to the loose pulley and the brake members 336 and 337 permitted to immediately and automatically clamp the shaft 54 and stop the entire machine.

The belt shifter is preferably so arranged as to move with the belt as the belt approaches the pulley in shifting it rather than against it, this action, thus utilizing the power of the belt itself to accomplish the shifting action, that is, the arm 294 is rotated in a counter clockwise direction or in the direction indicated by the arrow (Fig. 42) by the spring 302, through the shaft 299 and brack-

ets and link 296, 297 and 298. The driving movement of the belt is preferably in the direction indicated by the arrow shown in solid lines on the belt, and when the arm 294 comes in contact with the belt, the friction of the belt on the arm 294 will tend to rotate the arm in the above mentioned direction, the arm 294 being formed as shown, causes shifting movement of the belt in the direction indicated by the arrow shown in dotted lines, to the required extent, to remove the belt from the power pulley and shift it onto the idle pulley.

The various instrumentalities for releasing the belt shifter under various abnormal conditions will now be described. These include a take-up member 285 having an eye 286 at its forward end and fast at its rear end to a freely rotatable pin 288 in the bracket arm 279. A spring 289 fixed at 291 on the pin and to an adjustable post 292 tends to pull the take-up member up in a clockwise direction viewing Fig. 41. The yarn, indicated by reference character 293, normally holds this take-up member down against the force of this spring during knitting action, the arm taking up the slack in the idle reciprocation. As shown in Fig. 40 three such yarn feeds are provided, it being understood that one is arranged for each yarn carrier of the carrier container.

The lever 305 extends forward to beneath a sleeve 307 upon a yoke 308 (Fig. 44), one branch 309 of which extends through the sleeve and the other branch 311 extends across above it. The sleeve 307 is cut away at 312 to permit a lock and release for the lever 305, this lever being held down by the sleeve with the belt shifting member out of action when the part 312 is not presented to the lever end. A shaft 313 is arranged near the top of upward extensions 314 of arms 279 and carries levers 315 one arranged at each yarn feed and pulled in a clockwise direction by springs 316 fixed to the arms and to a spring clip 317. Each of the levers 315 is normally held out of action by a detent 318 pivoted on its companion arm 279 and having a latch end 319 engaging over a pin 321 on the lever. When the take-up arm 285 is released and enabled to move beyond its normal take-up movement a pin 322 secured to the rotatable pin 288 moves under the latch detent 318 releasing it and its lever 315. This lever then moves in the clockwise direction and hits the upper part 311 of the yoke 308 swinging the yoke and moving the sleeve 307 to release lever 305 and through the linkage previously described, and disclosed in Figs. 41 and 4, permitting the belt shifter to throw off the belt.

Means are also provided in the present instance for accomplishing a like result should the yarn feed foul. These means comprise an arm 323 (Figs. 40, 41 and 43) fixed to a collar 324 pivoted on a stud 320 from an arm 325 on a sleeve 326 integral with the arm 279 and on shaft 276, a duplicate arrangement being provided at each yarn feed. This arm 323 carries an eye 327 through which the yarn is fed. A spring 328 fast to the collar 324 and the spring clip 317 normally pulls the arm upwardly. The collar 324 is provided with a recess 329 against which rests the pointed end of an arm 331 pivoted at 332 to an arm 333 on shaft 313. A spring 334 normally pulls this arm over into position to engage the upper yoke part 311. When the yarn binds or becomes too tight the arm 323 is pulled down by the binding of the yarn, the collar 324 is rotated in a clockwise direction (viewing Fig. 43) and a projection 335 is pressed up under the arm 331 to free it of the recess 329 and cause shifting of the belt by the striking of the arm 333 against the yoke 311 to rotate sleeve 307 as described.

While the timing of the machine has been generally referred to, the time chart shown in Fig. 65 and the diagram shown in Fig. 66 may be useful in setting the several cams and devices to operate the machine. The vertical lines in this figure represent divisions of twenty degrees each of one complete cycle of operation of the machine. That is, one stroke in each direction of the cross head 88 and one complete revolution of the shaft 54, the entire cycle being represented by 360 degrees. The rectangular outlines 521 each represent one side of the needle bed or one bank of needles. A curved line 522 represents the relative speed or movement of the cross head and consequently the needle cams and cam slides 357 and the yarn carriers, all of which are indicated in Fig. 66, a horizontal line 523 indicating zero speed or movement, a line 524 indicating maximum speed or movement. Lines 525 represent the raising and lowering action of the needle cams when controlled by the pawls 247. It will be noted from these lines that when the needle cam is raised at the beginning of a cycle and the pawl is set to lower the cams, the lowering action will take place just before the needle cams enter the bank of needles, and if set to again operate the toothed wheel to raise the cams, this will take place before they return to the bank of needles. The dotted line represents an opposite situation where the cams are lowered at the beginning of a cycle and raised through the pawls 247, and then lowered on the second half of the cycle. From the above description it will also be evident that the needle cams may be either raised or lowered throughout a complete cycle. Lines 526 and 527 represent movement of the gates of the gate wheel 63. These lines each indicate one of the gates of this double gate wheel. If the gate is set to operate or shift the pattern member, for example, toward the left, this movement, will take place during the first twenty degrees of the cycle of

operation, so that the pattern will be shifted before the knitting cams enter the bank of needles and the gate is returned to neutral position just before the end of the first half of the cycle, or until shifted by its control arm. The line 527 represents the opposite gate, which may cause a similar shift during the second half of the cycle, and is similarly returned just before the finish of the cycle. While these lines have been shown to represent the gate as shifted in one direction only, it will be evident from the above description that they are shiftable in either direction and that they may be permitted to remain neutral upon occasion. Lines 528 and 529 represent the movement of the pattern member under the action of the gate wheel just described, and it will be noted from these lines that the shifting of the pattern member takes place immediately after the shifting of the gate. Lines 526 and 529 also indicate movement of the gate wheel 101 and the movement of the yarn carrier magazine or container. Line 531 represents the movement of the yarn holding hook. The four horizontal lines 532, 533, 534 and 535 represent the different positions of the hook as described in connection with Figs. 47 to 49, 51 and 52, the line 522 representing the position shown in solid lines, Fig. 47, the line 533 representing the position shown in Fig. 48, the line 534 representing the position shown in solid lines, Fig. 49, and the line 535 representing the position shown in dotted lines Fig. 49, and in solid lines, Figs. 51 and 52. Line 531 indicates that movement of the hook takes place during the last thirty degrees of the first half of the cycle so that the hook is in the projected position or in the position shown in Figs. 51 and 52 just before the reversal of movement of the cross head 88, and that the return of the hook is at the same rate of speed or ahead of the yarn carrier to one or the other of the lines 534, 533 or 532.

The vertical line 541, Fig. 66, represents the instant of knitting during the first half of the cycle of operation, or when the cross head 88 and the parts carried thereby, including the knitting cam, is traveling toward the right (viewing Fig. 66). The line 542 represents the instant of knitting when the above mentioned parts are traveling in the opposite direction or toward the left, viewing Fig. 66. The relative position of the knitting cam is fixed and the cam is arranged to knit at either end. For this reason the needles will be projected to points along a line 543, as shown, during movement of the slide in either direction. Due to the loose or shiftable connection of the yarn carriers with the yarn carrier engager at each reversal of direction of the cross head, the yarn carrier in use shifts from the position shown in solid lines to the position shown in dotted lines, so that the yarn will be deposited in or held in position for engagement by the needles, or substantially at the position shown, which is just after the commencement of the retracting movement of the needles, the dotted line position being the position when the cross head is traveling toward the left, and the solid line position being the position when the cross head is traveling toward the right. The cam slide 357 has one cam part 358 as previously mentioned and is moved by the cross head through the blocks 401, which are so spaced apart as to permit a shifting of the cam part 358 at each change of direction of the cross head 88, or twice during each cycle. This cam part is so arranged that it will cause a lifting of the yarn shedding devices substantially as shown in Fig. 66, or as indicated by the line 544. Viewing Fig. 66, it will be noted that the solid line position of the cam part 358 and the yarn shedding devices is the relative position when the cross head is traveling toward the right, and that the yarn shedding devices are lifted just before the instant of knitting and returned at the instant of knitting, or immediately thereafter. The dotted line position of the cam part 358 and the yarn shedding devices 544 represents the relative position when the direction of movement of the cross head 88 is reversed.

As stated in the objects, this machine is of the character of those shown in my earlier United States patents; that is, it includes mechanisms of an improved type for accomplishing the several results accomplished by the devices of these patents, and such results together with other new results in a new and improved manner. The latch needles used in this machine and the operation thereof in knitting is shown in all of these patents, and similar fabric that may be knit therewith is fully illustrated in United States Patents Nos. 819,407 and 1,531,272. A yarn control and belt shift, similar to that incorporated in this device, is shown and described in United States Patent No. 1,172,764. Similar pattern members, needle control cams and gate wheels are shown and described in United States Patents Nos. 996,059, 944,012, 1,201,691, 1,531,272 and 1,025,182. Similar pushers, or yarn-shedding devices, and knitting cams and knitting cam control are shown in United States Patent No. 1,201,691, and a similar controller or counting device is shown in United States Patents Nos. 996,059, 994,012 and 1,172,764. Since the operation of these several devices is fully described in the above-mentioned patents, and detailed descriptions thereof may be found in the specification along with the description of the parts, it is believed that a general description here will suffice.

In following the mechanism of my machine, it must be borne in mind that the application merely discloses one embodiment and that the machine in this embodiment is capable of adjustment to produce many results; that is, it

may produce garments of varied form, such as stockings, or the like, and any of these may be produced having different materials and patterns, or combinations of either; such as, for example, a stocking may be produced of one material in various sizes and having any desirable contour, or it may be produced of more than one material, such as with a silk body and lisle top and sole, or toe and heel, and in various sizes and of any contour, or it may produce either of the above having any desired pattern interwoven in the garment with yarn of one or more different colors, or, by varying the knitting action, to produce drop stitches, or the like, and thus produce various patterns with one color of yarn, and for the above reasons, some parts of the description may seem general since the parts referred to are capable of such varied results or construction and a general description must be given.

All of the moving parts of the machine, as disclosed in the present embodiment, are driven through the pulley 56 and shaft 54. This pulley and shaft rotate the gear 59 and shaft 61 continuously. The shaft 61 carries the gate wheels 63 and 101 and the cam 156, which are secured to the shaft and are rotated continuously thereby. The cross head 88, which is slidably mounted as previously described, is continuously reciprocated by the links 82 and 83, the link 82 being attached to the gear 59 which, as above mentioned, rotates continuously. The needle cam bars 227, the cam bars 357, for controlling the pushers or plates 354, and the connecting rod 344, for moving the yarn carriers, are attached to the cross head 88 and are reciprocated thereby through fixed cycles. Each stroke of the cross head, to the right in Fig. 3, brings the yarn carrier 94 into the yarn carrier retainer 91, where substitution of yarn may be effected, if desired. The needle cam bars 227 are secured to the cross head and the rod 344 is adjustably fixed to the cross head so that the relative position of a yarn carrier and the needle cams may be adjusted to deposit the yarn in position to be engaged by the hooks of the needles when retracted by the needle cams on either side of the machine. The needle cams, as in my earlier inventions above mentioned, are formed to project the needles when in operative position slightly in advance of the yarn carrier and to retract them with the yarn a sufficient distance to cause them to knit immediately after the passing of the yarn carrier, and this in either direction of travel so that knitting may be accomplished on either side of the bed on either stroke of the cross head. The pushers or plates 354 for determining the length of loop in the knitting action also serve to hold the yarn while the needle is being projected so that it is not necessary in this device to hang weights on the garment being knit, as has been the custom in this type of device. In operation these plates are preferably raised just before the needle is retracted and returned to determine the length of loop at the instant of knitting, and since the movement of these devices occurs slightly before and after the retracting movement of the needles, the position of the cam controlling these devices must be shifted at the end of each stroke to obtain the proper action. This is accomplished through the loose connection of the bar 357 to the cross head 88, that is, the blocks 401 may be secured to this bar in position to accomplish the desired effect.

The needles shown in my present embodiment are of the latch type, the operation of which is fully described in my earlier patents.

The needle jacks 78 and needle jack lever 77 and pattern member 76, for controlling the needle jack levers and needles, are also substantially like those shown and described in my previous embodiments, and in operation the needles are projected and retracted by the needle cams 232 and 233 when the cams are in jack-engaging position and when the needle jacks are in cam-engaging position. The needle jacks 78 are brought into or out of cam-engaging position by the pattern member 76, and the needle cams being carried by the pivot plate 229 are brought into or out of jack-engaging position by the wheels 245 and 249. The wheel 249 is engaged by pawls 247, one of which is pivotally mounted at each end of the needle bed and each of which the wheel engages in passing thereover in one direction only. The periphery of the pattern members 76 is divided into a plurality of segments and each of these segments may be arranged to project any number or combination of needles. Some of these combinations may be used only once in the knitting of a garment and others may be used any number of times, as desired. Pattern members 76 are also arranged to control the knitting cams and the pushers to vary the knitting tension and to control the knitting action. The knitting tension is controlled by varying the relative position of the plate 352, which carries the bar 357 for actuating the pushers, or by moving the plate about the pivot 359. By displacing the plate 352, all of the pushers are affected so that greater or less pushing action may be obtained to knit tighter or looser, as desired, and when the plate is moved about the pivot 359, the action of the pushers is varied; that is, a tight knitting will be effected at one side of the machine and the knitting will be varied to the other end of the machine, in accordance with the extent of movement about the pivot 359. The shifting of the bar is accomplished through the shaft 368 by the arm 371, set screws 373, 374 and 375 and the levers 376, which are actuated by the plates 372, attached to and forming a part of the pattern member. The normal position

of the bar is adjustable through the screw 381, which may engage either the needle bed or the frame of the machine. The shifting of the plate 352 about the pivot 359 is similarly effected through the collar 393 mounted on the shaft 368; the cam 388 pivotally connected to the collar and forming a part of the arm or bracket 389 attached to the lever 391 which is pivoted on the shaft 226 and is provided with a tooth 394 for engaging the cam 395 attached to and forming a part of the pattern member 76; the cam-engaging member 386 pivoted on the pin 385 fastened to the bracket 361, and the pivot member 384 engaging the bracket 382 which carries an adjusting screw 387. This may be adjusted by the screw 387 and various movements of the plate 352 may be obtained by varying the contour of the cam 388 and the teeth of the pattern cam 395. Shifting of the above-described mechanism is also accompanied by a shifting of the knitting cams. This is effected by the pin 396 attached to the collar 393 which engages the pin 242 secured to the plate 241 carrying the bushing 238 for shifting the knitting cam 232 to any of two or more positions. The shifting of the knitting cam effects a variation in the stroke of the needle and cooperates with the pushers to produce a tighter or looser fabric as desired. The cam plate 259 is also secured to and forms a part of the pattern members 76, and mechanism is provided which is adapted for operation by this cam plate and lever 258 for bringing the pawls 247 up into operative position or down out of operative position. The pawls 247 are for shifting the ratchet wheels 249 to bring the knitting cams into jack-engaging position or out of such position as above described. The needle cams are moved out of jack-engaging position and into jack-engaging position by the pawls in regular sequence. When the machine is knitting with one material all the way around in either direction and with any number of needles, they may also be moved into or out of jack-engaging position irregularly so as to cause either cam to knit during two or more consecutive strokes, such as when knitting a garment with two materials or when filling in a portion of a garment corresponding to the heel of a stocking where knitting would be at one end or on one side of the machine until the desired shape is obtained.

The pattern control and counting mechanism is provided to control the machine so that it will perform and repeat a series of operations, which may include any number of pattern combinations, yarn substitutions, or variations of the knitting action. This is accomplished by shifting the gates of the gate wheels 63 and 101 in either direction, as may be desired to accomplish the desired result. The gate wheel 63 controls the pattern members through the gears previously described, and the gate wheel 101 controls the position of the yarn carrier container to determine which container will be presented for engagement by the rod 344. By arranging the members 112, 113, 114 and 115 in accordance, any combination or shifting of one or the other, or both, of the above-mentioned devices may be effected. The number of times a combination will be repeated is determined by the counters 116 and their disks which form the grooves 177, this being accomplished through the cam 156 and the driving pawls operated thereby. The cam 156, as previously mentioned, rotates continuously and for each rotation of the shaft 61, which represents one stroke in each direction of the cross head 88, reciprocates the pawls twice in each revolution so that a shift may be obtained at either end of the stroke of the cross head. The control members 112, 113, 114 and 115 each have ratchet portions, each tooth of which represents a shifting of one or the other of the gates of the gate wheels, and each of the counters 116 have similar portions with ratchet teeth, each of which may represent a movement of the pattern control members by permitting the driving pawls to engage the ratchets of the control members or may prevent movement of the control members by holding the pawls out of action during any number of knitting strokes. It will thus be noted that the teeth in the grooves of the members 112, 113, 114, 115 and 116 may be arranged to produce any desired shifting of the pattern members 76 and the yarn carrier container 91 to produce and reproduce any desired pattern or size and design of stockings and other garments.

The controller 112 is arranged for continuous or interrupted rotation to produce any number of like alterations of the knitting action.

The controllers 113, 114 and 115 are separate parts arranged to operate sequentially and therefore embody one control pattern which may be added to or subtracted from by varying the number of parts. This pattern may also be subtracted from or added to by adding more controllers 112 or elminating that controller. The controller 112 in the present embodiment takes care of the repeated like alterations required in knitting the sole of the foot and a portion above the heel where the knitting is from intermediate the ends of and on one side of the bed around to a corresponding point on the opposite side of the bed and back again with one yarn, then substituting yarn and repeating the operation in an opposite direction from the points above-mentioned, or starting at the end of the bed adjacent the yarn carrier container and knitting to one point and then back around to the other and back to the end. The latter arrangement permits

of forming the control member 112 to shift only one gate of the gate wheel 63 as the shifting of yarn is always at the same end of the knitting stroke.

Counter devices are provided which include sufficient changes of movement to take care of the maximum number of combinations, which may be subtracted from at will by manual manipulation of either of the members 116 through the arm 214 and pawl 216. By selecting the proper members 116, any number of operations may be substracted from any portion of a garment. After the counting devices have gone through a complete cycle during which each disk has returned to its starting point, a new cycle is started by the last movement of the last counter member through the pin 204 secured to the end lever 176 which permits the starting pawl 158 to start off the controller 113. The first counter 116 is started by the last movement of the controller 115. It will, therefore, be noted that after completing one garment, the machine immediately starts another.

The yarn control devices include a tension device 284, which may be friction or otherwise, and adjustable to give the proper tension to various yarns, an arm 285 for taking up the slack in the yarn after passing the friction device, which is adapted to shut off the machine in the event of breakage of the yarn by operating the belt shifter 294, and a similar device 323 for operating the belt shifter in the event that the yarn is tangled or caught at the yarn spool. A set of these devices is provided for each yarn carrier and a different yarn may be threaded through each and to the yarn carriers, which are shiftable, as above described, to determine which of the yarn carriers are used and consequently which yarn is being knit.

In machines of this character, it is not frequently necessary to provide for more than three kinds or colors of yarn, since in stockings, as previously mentioned, the soles, top and body are ordinarily knit of two different kinds or colors of yarn, and where a design is knit in the stocking, different colors of yarn may be used. At times, this colored yarn may be intermittently used throughout the knitting or may be used only at one or more points intermediate the ends of the garment, and in this event it is preferable to cut the yarn after it is no longer required and hold the end until it is again required. While yarn carriers and other mechanism may be provided for more than one color, I have only shown mechanism to accommodate one. The cutting and holding of the yarn is accomplished by the hooked lever 431, which is actuated by the pin 435 secured to the pattern gear 69 and which actuates a pivoted lever 434. It is not necessary to cut the yarns that are used intermittently throughout the knitting. It is only necessary to hold these yarns to one side or away from the needles when they are connected with the garment at points removed from the ends of the needle bed, and the hook 445 is provided for this purpose and is adapted to hold the yarn clear of all needles and substantially parallel to the last needle upon which it is knit so that this yarn will not be knit in with other yarn in the next knitting stroke. This hook may be arranged to come to rest at any point intermediate the ends of the knitting bed to suit any garment being knit and is preferably arranged to be engaged by the cross head and to be reciprocated thereby at each stroke of the cross head, Figs. 47, 48 and 49, as previously described so that should the yarn be changed upon any stroke when the yarn carrier retainer is shifted, the yarn will be drawn across the hook or in position to be engaged thereby, Figs. 51 to 54 inclusive. The stop position of the hook or the position at which it holds the yarn is controlled by one of the cam plates 372 or a cam plate similar to the plates forming the grooves 372 and similarly attached to the pattern members 76. The cam plate may be formed to arrange lever 454 to engage the slide 446 to interrupt the rearward movement thereof at one or more positions which are determined by the garment to be knit.

The brake 74 mounted over the shaft 54 is operated simultaneously with the belt shifter so as to stop the machine instantly upon the default of or irregularity of yarn feed.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

This application has been divided and divisional applications filed as follows: Serial No. 123,069, filed July 17, 1926 for Knitting machines and relating to the needle projector; Serial No. 123,070, filed July 17, 1926 for Knitting machines and relating to the variable loop length mechanism, and Serial No. 123,071, filed July 17, 1926, for Knitting machines and relating to the yarn carrying and yarn changing mechanism.

I claim:

1. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movement of the pattern member throughout a period of the knitting

action wherein a considerable number of such movements of the pattern is desired, and a separate member controlling said pattern member where a less frequent number of reversals of movements of said patterns is desired.

2. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movement of the pattern member throughout a period of the knitting action wherein a considerable number of such movements of the pattern is desired, and a separate control controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said last mentioned control comprising a plurality of separately operable rotatable members for imparting to said pattern member characteristic pattern movements.

3. In a knitting machine, the combination of needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movements of the pattern member throughout a period of the knitting action wherein a considerable number of such movements of the pattern is desired, and a separate control for controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said last mentioned control comprising a plurality of rotatable members successively operable to impart pattern movement to said pattern member.

4. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movements of the pattern member throughout a period of the knitting action wherein a considerable number of such movements of the pattern is desired, and a separate control for controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said last mentioned control comprising a plurality of rotatable members successively operable to impart pattern movement to said pattern member, together with means for varying the controlling movement of each said rotatable member.

5. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movement of the pattern member throughout a period of the knitting action wherein a considerable number of such movements of the pattern is desired, and a separate control for controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said last mentioned control comprising a plurality of rotatable members successively operable to impart pattern movement to said pattern member, and an actuator common to all said rotatable members.

6. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movably to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movements of the pattern member throughout a period of the knitting action wherein a considerable number of such movements of the pattern is desired, a separate control for controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said last mentioned control comprising a plurality of rotatable members successively operable to impart pattern movement to said pattern member, and a driving member common to a plurality of said rotatable members and actuating them singly.

7. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movement of the pattern member throughout a period of the knitting action wherein a considerable number of such movements of the pattern is desired, and a separate control for controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said controls together comprising a plurality of rotatable members governing pattern movement of the pattern member, a said rotatable member being capable of variable rotation and said other members being successively rotatable.

8. In a knitting machine, the combination of, needles projectable from an inoperative to a knitting position, a pattern member determining the number of needles projected and movable to vary the needles as the knitting progresses, a control for the action of said pattern member producing alternately back and forward movement of the pattern member throughout a period of the knitting

action wherein a considerable number of such movements of the pattern is desired, a separate control for controlling said pattern member where a less frequent number of reversals of movements of said pattern is desired, said controls together comprising a plurality of rotatable members governing pattern movement of the pattern member, a said rotatable member being capable of variable rotation and said other members being successively rotatable, and a counter for coordinating the action of said rotatable members.

9. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a pattern member for determining the needle action, means selecting the particular yarn for a knitting action, and a controller, said controller comprising a plurality of movable members each controlling the selection of appropriate yarn and the movement of a pattern member.

10. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a pattern member, means for moving the said pattern member to any one of a plurality of needle action determining positions, means for selecting the particular yarn for a knitting action, and a controller, said controller comprising a plurality of movable members each controlling the selection of appropriate yarn and the movements of the pattern member.

11. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a pattern member, means for moving the said pattern member to any one of a plurality of needle action determining positions, means for selecting a particular yarn for a knitting action, and a controller, said controller including a movable member for controlling the yarn selecting means and the pattern moving means when frequent changes of yarn and of needle action are desired and a separate movable member governing the yarn changing mechanism and the pattern member when less frequent changes are desired.

12. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a pattern member for determining the needle action, means selecting the particular yarn for a knitting action, and a controller, said controller comprising a plurality of movable members each controlling the change of yarn and the direction of pattern movement of the pattern member, a said member being capable of indeterminate progressive action, and a plurality of said members being arranged to produce successive action of one member after another.

13. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a pattern member for determining the needle action, means selecting the particular yarn for a knitting action, and a controller, said controller comprising a plurality of movable members each controlling the change of yarn and the direction of pattern movement of the pattern member, a said member being capable of indeterminate progressive action, and a plurality of said members being arranged to produce successive action of one member after another, and a counting mechanism for coordinating the action of said several members.

14. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a movable pattern member for determining the needle action, means having a device selecting a particular yarn for a knitting action, and a controller, said controller comprising a plurality of moving members for governing the yarn selecting means and the movement of the pattern member, pawls for driving each of said members, a counting device, and means actuated by the counting device for lifting a said pawl out of action throughout a predetermined knitting period while permitting a second pawl to remain in operative position.

15. In a knitting machine, the combination of a needle bed, needles carried thereby, a plurality of yarn carriers, a pattern member for determining the needle action, means selecting the particular yarn for a knitting action, and a controller, said controller comprising a plurality of moving members for governing the change of yarn and the pattern movement of the pattern member, pawls for driving said members, a counting device, and means actuated by the counting device for lifting a said pawl out of action throughout a predetermined knitting period while permitting a second pawl to remain in operative position, and a member governed by one or more of said movable members for lifting a said pawl out of action and permitting a second pawl to remain in operative position.

16. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, and a yarn carrier reciprocating across said needles and adapted to supply yarn to the needles during a knitting stroke in each direction, a pattern member for controlling the needle action, means for positioning said pattern member, and a control for said positioning means operable prior to a said knitting stroke in order to arrange said pattern member in position for the knitting stroke.

17. In a knitting machine, the combination of a needle bed, needles carried thereby, a pattern member for selecting and controlling the projection of needles into operative position, means for moving said pattern member to various needle selecting positions, a controller for determining said movement, said controller comprising a plurality of action determining members and counting members,

reciprocating pawls, means moving said pawls into and out of action as knitting conditions require, a pawl for starting said action determining members upon a cycle of knitting operation, and a member on said counting device for arranging said starting pawl in starting position at the end of a knitting cycle.

18. In a knitting machine, the combination of a needle bed, needles carried thereby, a pattern member for selecting and controlling the operation of said needles, means for moving said pattern member to various needle selecting positions, a controller for said movement, said controller comprising pattern action determining members and counting members, pawls movable into action as occasion requires, and means brought into action by the final movement of the action determining members for arranging a pawl in operative position to start the initial movement of the counting members in the next knitting cycle.

19. In a knitting machine, the combination of a needle bed, needles carried thereby, a pattern member for selecting and controlling the projection of said needles, means for moving said pattern to a predetermined needle selecting position, a controller for predetermining said movement, said controller comprising pattern action determining members and counting members, pawls movable into action as occasion requires, and means brought into action by the final movement of the action determining members arranging the counting mechanism in operative position to begin the counting in the next knitting cycle.

20. In a knitting machine, the combination of a needle bed, needles carried thereby, a pattern member for selecting and projecting said needles, a controller for said pattern member, said controller comprising a plurality of rotatable members for determining the pattern action, said members having continuous slots, control members resting in said continuous slots and said rotatable members having cam surfaces adapted to move said control member to vary the pattern action.

21. In a knitting machine, the combination of a needle bed, a plurality of yarn carriers, a yarn carrier selector, and a controller, said controller comprising a plurality of rotatable members having continuous slots therein, control members adapted to rest in said slots, said rotatable members each having cam surfaces formed in the slots adapted to move a said control member between at least three positions and actuate said yarn selector to change the knitting yarn.

22. In a knitting machine, the combination of a needle bed, needles mounted thereon, a pattern member for selecting and projecting said needles to knitting position, a plurality of yarn carriers, a yarn selector, and a controller, said controller comprising a plurality of rotatable members having continuous slots for a pattern control member and seam slots for a yarn selector member, the slots in each said rotatable member being arranged to move the pattern member in either direction and actuate the yarn selector in either direction to change the knitting yarn.

23. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arrangeable to cause shifting of the pattern member, in either direction and twice during each reciprocation.

24. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arrangeable to cause shifting of the pattern member in either direction and twice during each reciprocation, and to cause the substitution of one of the yarn carriers for another at least once during each complete cycle of operation of the reciprocating member.

25. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arranged to cause movement of the pattern member in either direction and to cause substitution of yarn carriers, said device including a plurality of intermittently rotatable members, one of which is arranged to cause continuous and uniform forward and backward movement of the pattern member, and a counting mechanism for controlling said rotatable members.

26. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arranged to cause movement of the pattern member in either direction and to cause substitution of yarn carriers, said device including a plurality of intermittently rotatable members, one of which is arranged to cause a continuous and uniform forward and backward movement of the pattern member and a corresponding substitution of yarn carriers, and a counting mechanism for controlling said rotatable members.

27. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arranged to cause movement of the pattern member in either direction and to cause substitution of yarn carriers, said control device comprising a plurality of intermittently rotatable control members, one of which is arranged to cause repeated uniform movement of the pattern member in both directions, and the remainder of which are arranged for progressive rotation to cause regular or irregular movement of the pattern member in either or both directions, and a counting mechanism for controlling said rotatable members.

28. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arranged to cause movement of the pattern member in either direction and to cause substitution of yarn carriers, said control device comprising a plurality of intermittently rotatable control members, one of which is arranged to cause repeated uniform movement of the pattern member in both directions, and the remainder of which are arranged for progressive rotation to cause regular or irregular movement of the pattern member in either or both directions, and a counting mechanism for controlling said rotatable members, said members comprising a plurality of intermittently and progressively rotatable devices that are arranged to repeat continuously.

29. In a knitting machine, the combination of a needle bed, needles, means for projecting the needles, yarn carriers arrangeable to supply yarn to the needles, a reciprocating device for reciprocating one of said yarn carriers across the needle bed to supply yarn to the needles, a pattern member for controlling the needle action, and a control device arranged to cause movement of the pattern member in either direction and substitution of yarn carriers, said control device comprising at least one progressively rotatable disc arranged to cause movement of the pattern member and substitution of yarn carriers, and an automatically repeating counting device for controlling said rotatable member.

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